POWER PLANT ENGINEERING

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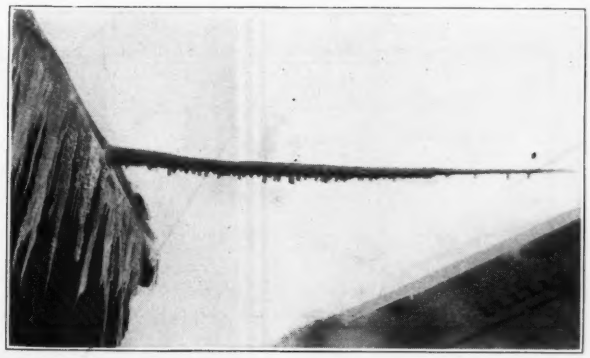


Nature Will Have Her Fun

UNDER PROPER conditions, nature needs only a thread upon which to build a mass which frequently causes a great amount of trouble and even destruction of property. Scarcely a hundred years ago, the thrifty pioneers employed the dipping process in making candles to furnish light. The principle employed differs but little from that used by nature in the making of icicles or the coating of wires, clothes lines and twigs with ice during what is commonly know as a sleet storm. Stalactites and stalagmites differ somewhat in principles of formation but here, again, a slender thread may be the skeleton upon which nature works.

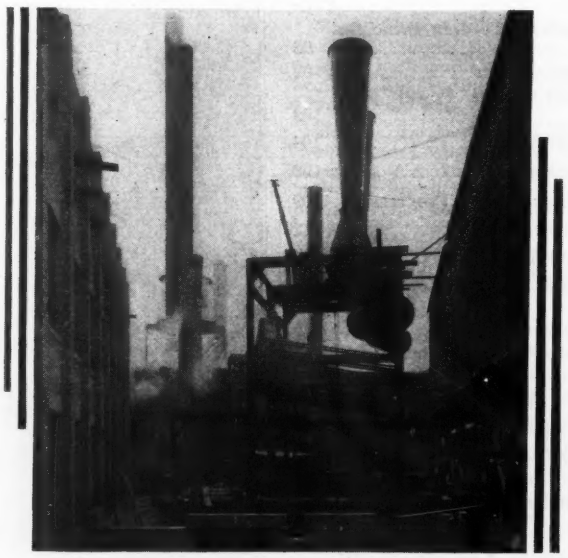
In the course of his work, the engineer will encounter these habits of nature. In some cases, they can be used to advantage but in most cases, accumulations give unending trouble and preventive methods must be devised. Prevention of the formation of boiler scale has taxed the ingenuity of our best engineers and chemists. Slag on furnace walls, soot on tubes, frazil ice on trash racks are all "weeds" which the power plant engineer must destroy.

Then, again, the designer sometimes overlooks what difficulties may arise due to the arrangement of necessary equipment. Witness the photograph at the head of this column. Here we have an ideal icicle factory. The electric line leaves the power plant at a point where it is almost continuously bathed in vapor from an exhaust pipe. The remedy was obviously to change the location of the exhaust but it was necessary to go through the above experience before the changes would be authorized.

Now turn to the next page and learn how the power plant has supplanted the housewife in the making of one household, or would you call it personal, article built entirely on a thread.

SMALL INDUSTRIAL POWER PLANT

BUILT ON MODERN PRINCIPLES OF DESIGN



By H. P. SMITH
Engineer, Henry R. Kent & Co.

IN THE DESIGN OF a modern industrial power plant, the engineer is being called upon more and more to design a plant to meet the peculiar requirements of mills manufacturing specialized products.

Unfortunately, the mill owner seldom realizes the very vital part played by his power plant and considers his contemplated plant as a necessary evil so that, in too many instances, these plants not only have to fulfill the exacting demands upon them but have to be so designed to fit limited areas alloted to them. Such a plant has just been designed, constructed and completed for William Willheim Company, Inc., at Passaic, New Jersey, the engineering and construction of which was performed by Henry R. Kent & Co., engineers and constructors.

This mill is devoted to silk dyeing, printing and finishing, which requires not only electrical energy but large volumes of steam of varying pressures and quality. The demands for this power are such that the load curve is very irregular, with sudden and extremely heavy peaks.

In the accompanying drawings is shown the layout of the power plant developed to meet these requirements and it should be noted that the equipment is housed on a ground area of 3294 sq. ft. including the building itself.

The equipment consists of two 600-hp. cross-drum water-tube boilers set in battery with ample accommodation for a third unit set singly. These boilers are equipped with chain grate stokers with the usual forced draft fans delivering air through a steel duct arranged so that either fan can furnish air to either stoker. The induced draft is obtained with Venturi type stacks and fans, one for each boiler. Forced draft, induced draft and feed pumps are all turbine driven.

There are two 300-kw. turbine generators with switching equipment and with ample space provided for a third unit of like capacity.

Steam Generated at 175 Lb.

All the steam generated by the boilers at 175 lb. working pressure is used in the mill processes, but at a materially reduced pressure. This condition lends itself admirably to the use of turbine-driven prime movers which act as reducing valves. As the inherent economy of the turbines driving the auxiliary apparatus is negligible, all of the exhaust steam being used for process, simple, sturdy equipment was selected, as its first cost is materially below that of the more economical design. On the other hand, the turbines for driving the generators were designed to give the best economy that could be secured for units to operate at the high back

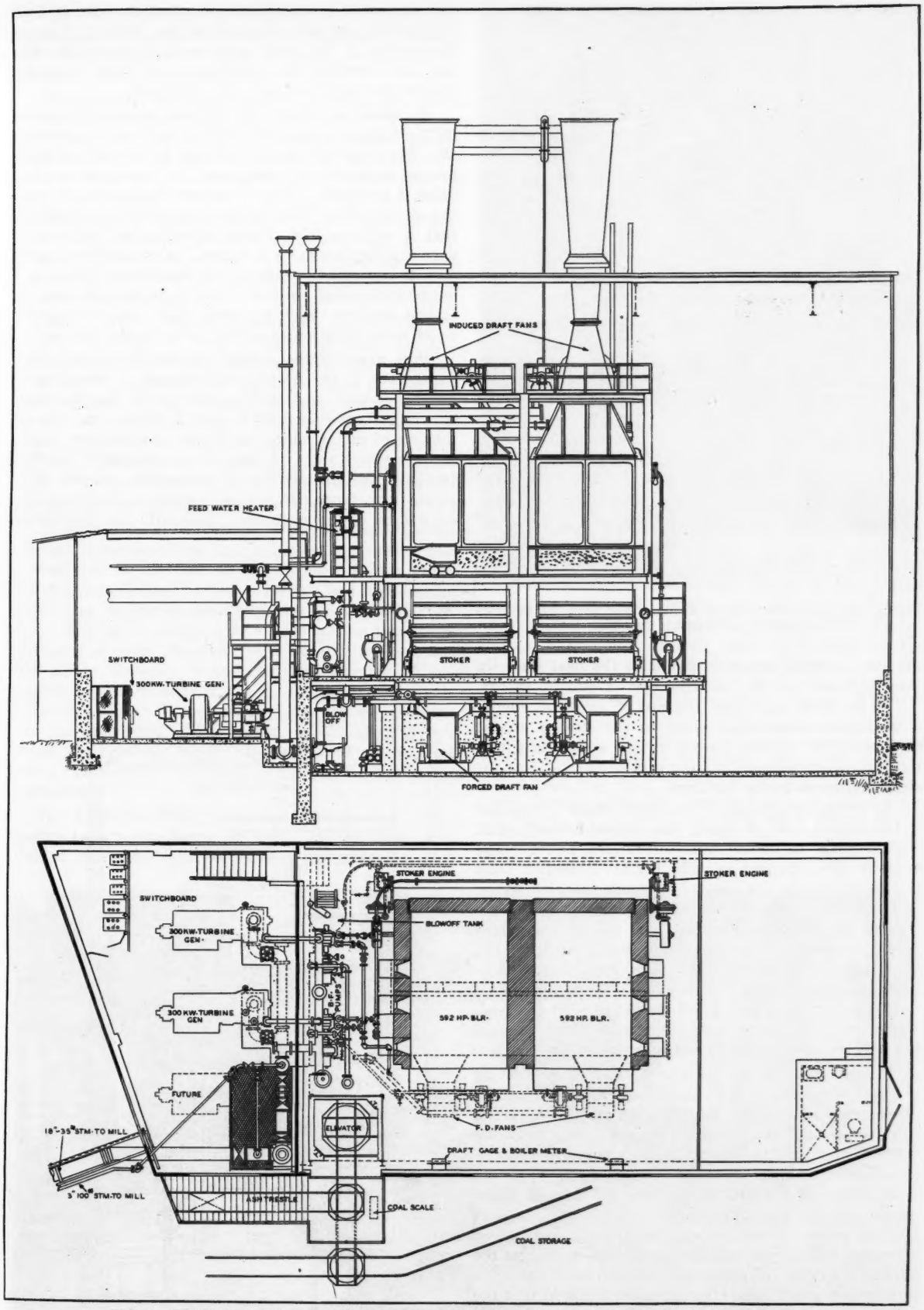


FIG. 1. PLAN AND ELEVATION SHOWING ARRANGEMENT OF EQUIPMENT OF THE PLANT

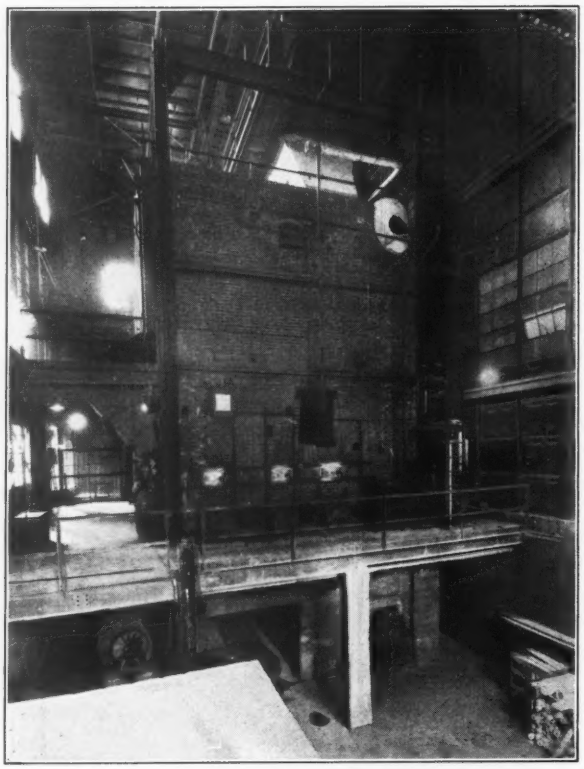


FIG. 2. SIMPLICITY AND ORDERLINESS ARE FEATURES OF THE BOILER ROOM

pressure involved, so as to minimize the heat losses in these turbines and the resulting cost of electric energy.

Under these conditions, the cost of electrical energy is negligible, being about equal to the interest on the investment for turbine generators and switching equipment, plus approximately 7 per cent of the value of the steam delivered to the turbines.

As the major portion of the process steam is required in the mill at 35 lb. or less, it was deemed advisable and advantageous to deliver steam from the power house at 35 lb. pressure and to make further reduction from this pressure, where necessary, through reducing valves at the machines themselves. In order to meet this requirement, the main turbines and all turbine-driven auxiliaries exhaust against 35 lb. back pressure. The only exception is the stoker drive, which, being a reciprocating engine, exhausts through an oil separator direct to the heater. The balance of steam required for feedwater purposes is obtained from the 35-lb. exhaust header through a reducing valve to the heater.

During what might be termed an average load in the mill, the turbines and auxiliaries are delivering approximately 35 per cent of the process steam required, so that the balance is obtained by means of a reducing valve delivering steam from the high-pressure main to the exhaust main.

Selection of the proper reducing valve is of major importance, for this valve must be able to pass the total process steam required when the turbines are not in operation and it must also be capable of delivering the minimum amount of make-up steam required when the turbines are operating. It can readily be seen that the valve must be capable of a very wide range of steam flow and must be exceedingly sensitive in order to hold the delivery pressure constant, so that there will be no fluctuations in the steam pressure delivered to the mill and also prevent the building up of back pressure against the main turbines and auxiliaries.

In order to protect the turbines against the possibility of the reducing valve failing to function properly and also to permit them to exhaust to atmosphere when process steam is not being used, an atmospheric relief valve is provided. This valve must be capable of passing all the steam from the turbines and be so designed that it will not blow down below the set pressure as does a safety valve on a boiler. It is therefore necessary to use extreme care in the selection of the proper atmospheric relief valve to fulfill these requirements. It is best that the main reducing valve and atmospheric relief valve function as a unit under master control.

It is conceded that a good combustion control is advantageous to the proper and economical operation of any boiler plant and will unquestionably pay for itself within a short time both in saving of fuel and the reduction of maintenance on boilers and settings, but in a plant where the load curve is so extreme in its fluctuations, the installation of combustion control is of prime importance. In manual operation, the firing crew cannot be expected to keep pace with the fluctuating

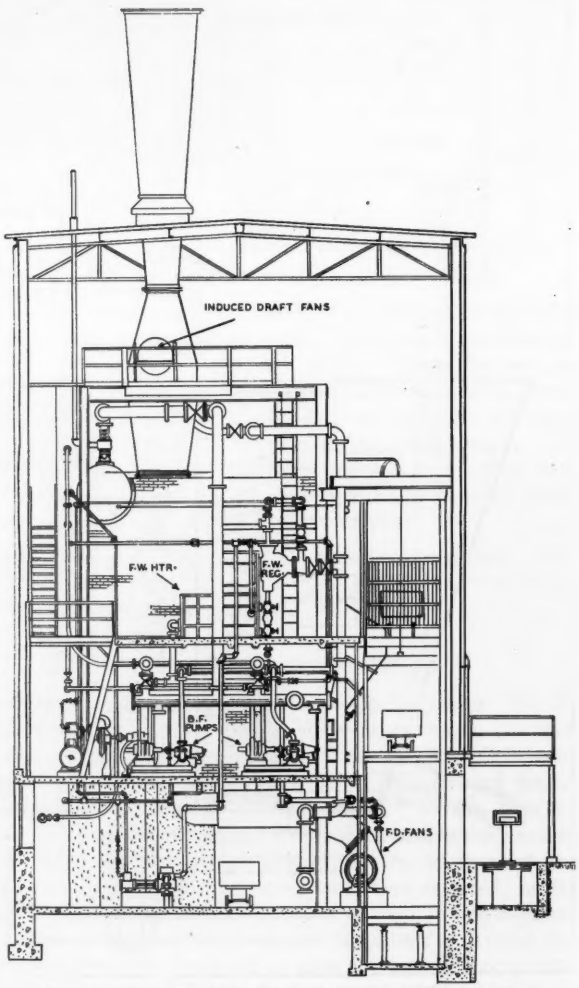


FIG. 3. SIDE ELEVATION OF THE BOILER ROOM

demands in adjusting the induced, forced draft and stoker speeds, for no sooner has a balance been reached, than the demand is changed, requiring complete readjustment of all apparatus.

Space limitations for this plant preclude the use of a conventional isolated stack. As a self-supporting steel stack mounted on the boiler structure or the use of stub stacks with induced fans would necessitate extremely heavy steel construction, the Thermix type of stack was selected. Unless proper furnace draft conditions are maintained at all times, there is a tendency, when using the small grades of anthracite coal, to emit cinders to a very objectionable extent, which again emphasizes the necessity for combustion control to maintain the proper draft.

The building enclosure consists of a concrete foundation to the height of boiler room firing aisle. On this foundation is erected a so-called standard steel building. This type of structure, the peculiar shape of building and the limitations of the appropriation, did not permit the use of an overhead coal bunker with the usual coal elevators, conveyors, etc. The power plant is so situated that it was impossible to arrange for rail delivery of coal. The coal is delivered by truck to a triangular storage area adjoining the power plant.

In view of these limitations, it was necessary to provide an economical coal and ash handling system and to meet this requirement, the arrangement shown on the drawing was devised. Coal is loaded into ball-bearing dump cars, having a capacity of approximately 1300 lb. each. The car is pushed over a scale and on to a steam hydraulic elevator which raises the coal to a mezzanine floor at the elevation of extended coal hoppers. These hoppers have a capacity of approximately five tons each. Ashes are removed from ash hoppers in the basement into the same cars, and by means of the elevator, are raised to an elevated trestle outside of the building from where the ashes are dumped to the ground ready for disposition.

The mills for which this plant furnishes the power, operate twenty-four hours per day. The power plant is divided into three 8-hr. shifts with an operating crew of four per shift, consisting of an engineer, one fireman and two coal and ash handlers. The engineer on one shift is a first-class licensed man, while those on the other two shifts are second-class engineers.

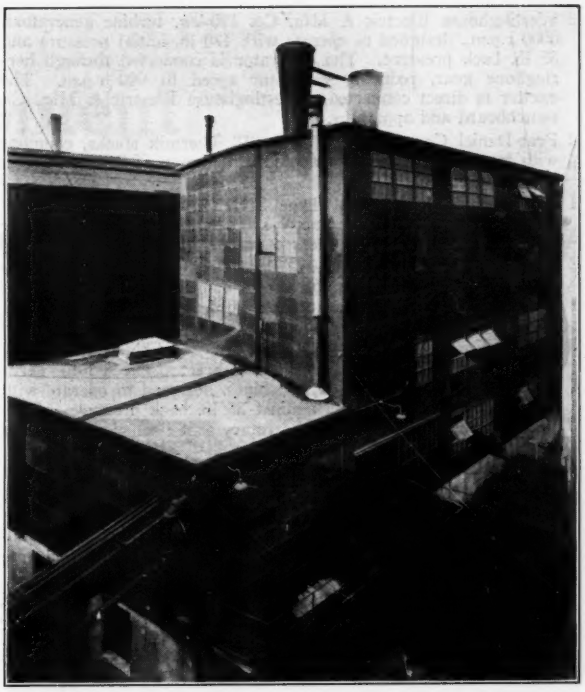


FIG. 5. THE BUILDING IS OF STEEL, ON A CONCRETE FOUNDATION

PRINCIPAL EQUIPMENT INSTALLED IN THE WILLIAM WILLHEIM CO., INC., POWER PLANT

2 Combustion Eng. Corp., Type "MC" Heine cross-drum boilers of 592 hp. each, designed for an operating pressure of 180 lb. gage.

2 Combustion Eng. Corp., Type "B" Coxe chain grate strokers, with Clarage engine drive. Stokers designed to operate boilers at 200 per cent of rating continuously and at 300 per cent of rating for 2-hr. peaks, when burning No. 3 Buckwheat Anthracite coal.

M. H. Detrick Co. stoker arches.

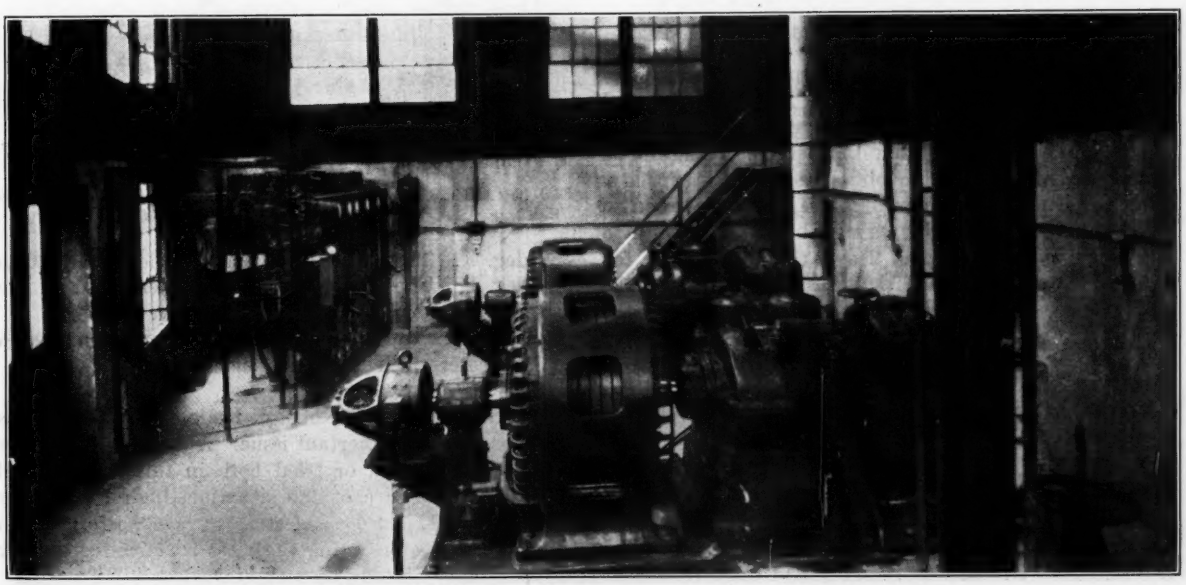


FIG. 4. TWO 300-KW. TURBINE GENERATORS SUPPLY ELECTRIC POWER

2 Westinghouse Electric & Mfg. Co. 300-kw. turbine generators, 6000 r.p.m., designed to operate with 170 lb. initial pressure and 35 lb. back pressure. The generator is connected through herringbone gear, reducing generator speed to 900 r.p.m. The exciter is direct connected. Westinghouse Electric & Mfg. Co. switchboard and apparatus.

2 Prat-Daniel Corp. No. 806 Type "I" Thermix stacks, complete with fans and designed to provide a minimum of 2.5 in. of draft at base of stack.

1 Swartwout Co. Universal Type Style "A," 3-unit, 36-in. feedwater heater, having a capacity sufficient to deliver feed water at 210 deg. for the two boilers operating at 200 per cent rating.

2 Dean Hill Pump Co. 2½-in. Type "A," 3-stage, volute type centrifugal boiler feed pumps, direct connected to Terry Steam Turbine Co. Type Z-2 turbines designed to operate with 170 lb. initial pressure and 35 lb. back pressure.

2 Buffalo Forge Co. No. 4½ Type TDHG, double width, double inlet, heavy duty, forced draft fans, direct connected to Terry Steam Turbine Co. Type "Z" turbines, designed to operate with 170 lb. initial pressure and against 35 lb. back pressure.

5 Vulcan Soot Cleaner Co. 1½-in. rotary soot cleaner elements for each boiler.

1 L. R. Merritt & Co.'s steam hydraulic elevator of 300 lb. capacity, having a 21-ft. 6-in. lift with a car platform, 6 ft. 6 in. by 7 ft. 6 in.

1 Fairbanks-Morse & Co. industrial railway scale, having a platform 5 ft. 1 in. by 2 ft. 6 in., capacity of 4 tons and with type registering beam.

1 Easton Car & Construction Co. rotary scoop cars for coal and ash, having a capacity of 27 cu. ft. Sixty-inch and forty-four-inch turntables with necessary 24-in. gage track.

2 Bailey Meter Co. Type "D" 25 Class No. 1 boiler meters to indicate and record steam flow and to record air flow.

2 Ernst & Co. Superior Type inclined water gages.

Engineer Company, automatic combustion control.

Piping—

Gate valves	Chapman Valve Mfg. Co.
Globe valves	The Lunkenheimer Co.
Non-return valves	Foster Engineering Co.
Blowoff valves	Everlasting Valve Co.
S-C feedwater regulators	Swartwout Co.
Reducing valves and excess pressure regulators	Fisher Governor Co.
Low-pressure copper expansion joints	Griscom-Russell Co.

Hubbard Mills Changes to Pulverized Fuel

MILLING COMPANY AT MANKATO, MINN., REPLACES FOUR SMALL WITH ONE LARGE BOILER

OLD BOILER EQUIPMENT in the plant of the Hubbard Milling Co., with a capacity of 3500 barrels of flour per day and suitable grain storage and cleaning equipment, consisted of four 72 by 18-in. h.r.t. boilers. The load was such that all four had to be under fire, so in order to obtain additional capacity, better efficiency and higher pressure, it was decided to put in one pulverized coal firing unit large enough to carry the entire load and leave the old boilers for stand-by service. An addition was built to house the new boiler unit and the installation was made ready for service without interfering with the operation of the mill.

F. E. Browder, vice-president, and George F. Schreiber, chief engineer, planned the new installation and selected the equipment which consists of a Kidwell, 4110-sq. ft. boiler, with a 2280-cu. ft. solid wall furnace fired by a 2500-lb. capacity Unipulvo pulverizer, as shown in Fig. 1. A Ljungstrom, 21,600-sq. ft. air preheater and the following boiler room instruments were also selected: Brown CO_2 recorder and temperature recorders for flue gas and air both to and from the air preheater; Simplex, Venturi feedwater meter and R-K automatic regulator on the air and coal feed to the mill.

Southern Illinois coal is used. The new equipment was put into service in October, 1928, and has been in continuous service since that time, six days a week. All the air required for combustion is taken through the air preheater and mill going to the latter at from 350 to

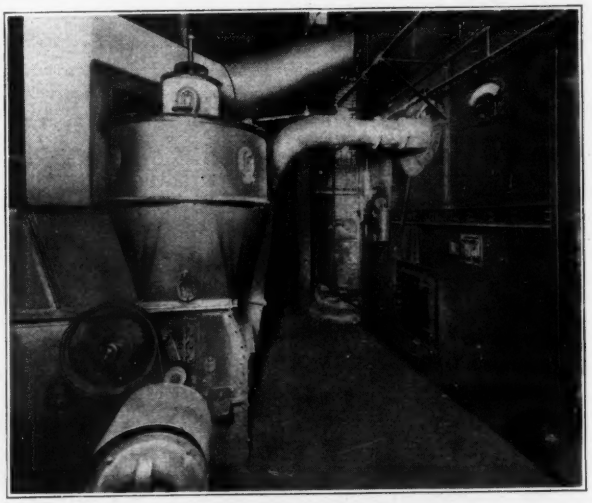


FIG. 1. PULVERIZER INSTALLATION IN HUBBARD MILLING CO. PLANT

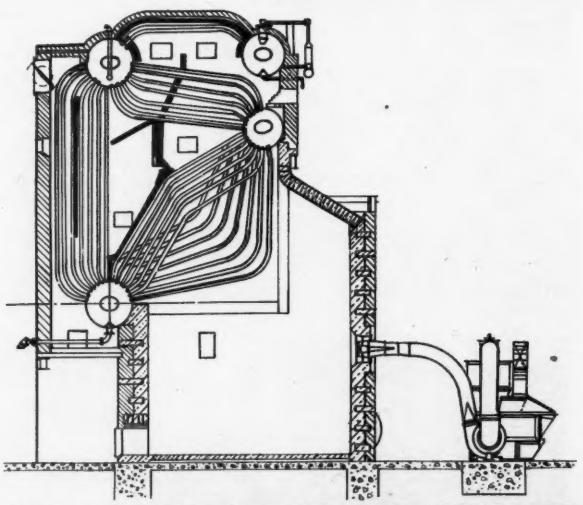


FIG. 2. CROSS SECTION OF THE BOILER SHOWING THE PULVERIZER ARRANGEMENT

380 deg. F. The stack temperature varies from 320 to 340 deg. F. The rating averages 175 per cent and the ash is dry, carbon-free and easily removed.

Tests show an average over all, boiler, furnace and air preheater efficiency of 85 per cent.

METHODS OF CARRYING peak loads on power systems are becoming an important issue. A number of schemes have been proposed or tried both in this country and abroad to take care of the situation, high level water storage, Diesel engines, electric storage batteries, and steam accumulators being the most practical. All four methods have already been tried.

It Is Available Equipment *that makes* Power Plant History

EQUIPMENT DEVELOPED BY THE MANUFACTURER LAST YEAR WILL BE USED BY ENGINEERS TO BUILD NEW AND MODERNIZE OLD PLANTS THIS YEAR

HOW OFTEN do we review power plant progress without thinking of the equipment that makes this progress possible?

We like to look at the downward trend of the heat consumption curve of recent years, tracing its drop through 20,000 to 15,000 and 12,500 B.t.u. per kw-hr. with perhaps a glimpse ahead to the time when 10,000 or even 9000 kw-hr. will be practical.

We do not say possible, because it has already been proved possible in the binary vapor plant at Hartford. New developments may even better these figures. It is not beyond the bounds of probability to suppose that some use for low temperature heat may eventually be discovered which will eliminate the usual condenser loss and more than double the thermal efficiency of condensing steam plants.

PIONEER OPERATORS AND MANUFACTURERS WORK TOGETHER ON NEW DEVELOPMENTS

We are inclined to forget that all new developments are made practical by the manufacturers of equipment. Pioneers forging ahead specify equipment which will answer their needs. Seldom do they build such equipment themselves, preferring rather to depend upon the skill and ability of manufacturers experienced in similar design and conditions.

Following those pioneering efforts, changes are made in the light of actual performance and the new equipment or apparatus put on the market available to the industry as a whole. Until this is done, no new discovery or development is practical.

Such a procedure calls for initiative and development work far in advance of the industry. Thus the summary of this year's work by manufacturers is a glance into the future. Equipment which they have perfected and announced this year will next year be in use in thousands of new power plants and being used by thousands of wide awake engineers to improve the performance of old plants.

Not all developments are in an unexplored field. The progress of the industry has been so rapid that many plants modern in their day, are obsolete. There is a definite demand for equipment to rehabilitate them.

New low head room boilers, high temperature superheaters, improved pulverizers, new stokers, water wall construction with natural and forced circulation, boiler designs with water walls built integral, feedwater control equipment, better piping and valves, centralized control equipment are some of the more recent developments.

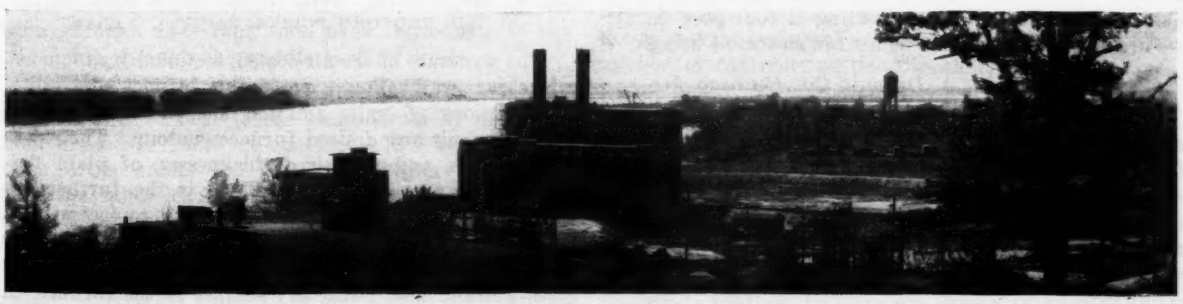
In the electrical end, all types of equipment from the giant 160,000-kw. generator down to fractional horsepower motor starters show the widespread interest of manufacturers in meeting all possible demands of operators and designers.

A GLIMPSE AHEAD FOR THE PROGRESSIVE ENGINEER

Of particular interest are the developments to meet the increasingly complex demands of industrial plants; new speed changers, unit heaters, welding equipment and the adaptation of small steam turbine drive to many novel uses.

It is to bring the engineer in touch with all the new developments that manufacturers have to offer that we present a review annually; a review that is at once a record of accomplishment for the manufacturers and a look forward for the engineers.

We regret that present power plant equipment is so varied in character that we cannot cover all classes of equipment each year but we believe the lines which we have included this year are representative of the progress made by the industry as a whole.



Boilers, Superheaters and Furnace Walls

SEVERAL NEW BOILER DESIGNS, SUPERHEATERS FOR 775, 825 AND 1100 DEG. F. AND IMPROVED WATER WALL CONSTRUCTIONS FEATURE YEAR'S PROGRESS

STATEMENT BY THE BROWNELL CO.

IN BOILER CONSTRUCTION on the standard type of portable boilers, the Brownell Co. has included a design which eliminates the use of the mud ring on the firebox sides, thereby strengthening the boiler by eliminating the need of extra long rivets, and at the same time giving a much stronger construction.

On the welded type boiler, we have taken our standard type boiler and added thereto the series of water

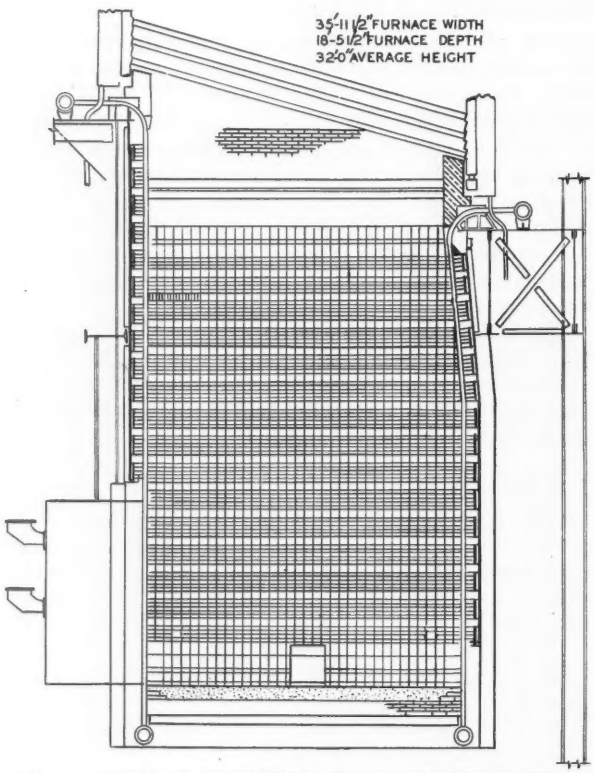


FIG. 1. DETRICK SECTIONAL WALL ENCLOSING BARE TUBE FURNACE LINING AT DEEPWATER STATION

tubes which lie in the entire length of the boiler, giving us an increase of about 22 per cent in boiler capacity without an increase in outline dimensions. It also enables us to reduce the original steaming time by one-half. With this addition, creating a four-pass boiler, we are enabled to use this boiler for gas or oil firing.

STATEMENT BY M. A. DETRICK CO., CHICAGO, ILL.

Sectionally supported furnace walls have undergone recent development for both stoker and pulverized fuel furnaces. There is a definite economic requirement for refractory walls in modern furnace design, just as there is definite economic requirement for water-cooled furnaces. The objective in designing refractory furnace walls is to make them stand up under modern firing conditions.

For stoker furnaces in general, and for certain classes of pulverized fuel furnaces, the principal method of securing satisfactory life of refractories, is to support them in unit sections, and to air cool them. The sectional support eliminates crushing strains from the hot refractories, and permits of expansion and contraction largely within the sections themselves. In addition, the support is by means of outside steel framing, and cast-iron hangers, so arranged as not to be subject to heat, with the result of maintaining permanent alinement of the wall.

FLEXIBILITY OF FURNACE CONTOUR ALLOWED

Air cooling is secured by the simple means of providing an outer wall surface of either brick or steel casing. The cooling air may be circulated by gravity when its heat is not reclaimed, or by proper connection with the air supply to the furnace when it is expedient and economical to save the heat.

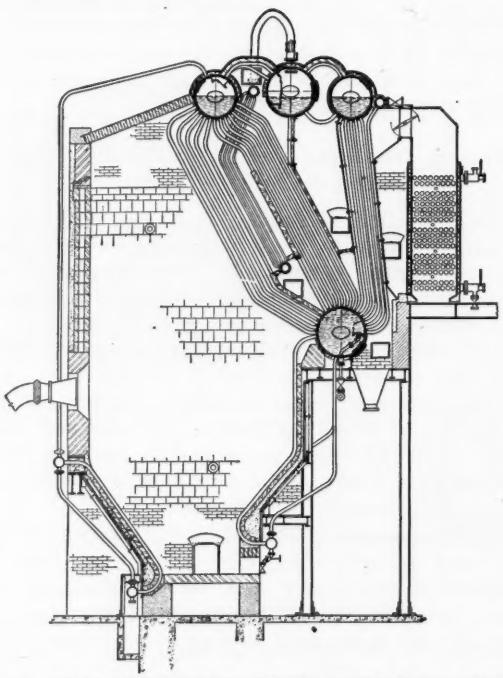


FIG. 2. EDGE MOOR, FOUR DRUM, BENT TUBE BOILER AT THE BEDFORD PULP & PAPER CO. PLANT

The structure of the air-cooled, sectionally supported, refractory wall allows maximum furnace flexibility. Combinations of walls and flat suspended arches are formed to suit any desired furnace contour. The excessive weights, and undesired thicknesses, of plain firebrick walls, are eliminated. There is the further advantage in time saving when refractory replacement is necessary, which decreases the important item of boiler outage to a minimum. Any replacement of refractory gives a brand new refractory surface in the furnace, in

its original alinement, and no bonding of new refractory with old is required.

A recent development by the M. H. Detrick Co., for pulverized fuel-fired furnaces, is a sectionally supported refractory wall, forming the outer shell of the furnace and completely independent of the tubes used for heat absorption. The refractory wall, in this case, need not be air-cooled, as its temperature is comparatively low due to the shading by tubes. It is, instead, covered with suitable insulation and enclosed in a steel casing, thus forming a permanent air-tight wall. A particular advantage of this construction is that the tubes, which have a definite movement, due to expansion and contraction, and at times due to the changing location of their headers, may shift as required without strains of any kind on the refractory furnace shell, which consequently remains air-tight as is necessary.

The illustration of such a furnace, shown in Fig. 1, is evidence of the size and simplicity easily secured by the construction described. It should be noted that the sectionally supported areas may be at any location in the furnace wall and that any other construction, such as plain fire brick or special tile where tubes enter or leave the furnace, may be located adjacent to the sectionally supported construction, without imposing any load on them or vitiating any of their desirable characteristics.

While the illustration shows the sectionally supported construction of refractory wall in combination with bare tubes, it is obvious that it is applicable to combination with any style of heat absorbing surface and that in any of the combinations it secures the independent, permanently air-tight furnace casing that is always required.

Statement by the Edge Moor Iron Co., Edge Moor, Del.

During the past year, the Edge Moor Iron Co. has designed and developed the Edge Moor four-drum bent tube boiler, a typical installation of which is shown in detail by Fig. 2. This boiler consists primarily of four cross drums and three banks of tubes. The tube banks are so developed as to allow a three-pass gas travel at a practically uniform speed.

Feedwater is fed into a header located at the top of the boiler directly behind the rear drum. From this header it flows down to the mud drum, up to the top rear drum and back to the mud drum. This progressive method of heating the feedwater is produced by means of internal drum baffles in the mud drum and produces an economizer effect, a distinctive feature of the Edge Moor bent tube boiler. The water then enters the main circulation of the boiler, flowing up to the front top drum through the front tube bank, returning to the mud drum through the middle bank of tubes.

Steam collecting in either the front or the rear drums is carried over to the steam drum by means of short cross-over tubes at the top. The water in the steam drum enters the boiler circulation by flowing down the tubes leading to the mud drum. The steam drum, being thus partially isolated from the boiler circulation, remains comparatively quiet, another distinctive feature of the Edge Moor bent tube boiler. This feature permits the boiler to be operated at high ratings and yet deliver comparatively dry steam at the steam outlet.

Edge Moor Water Walls

Demand for higher ratings and the space requirements to be met in the manufacture of boilers has led to the development of the Edge Moor Bare Tube Type water wall. In this wall, the tubes are directly exposed to heat and form the furnace wall. They are backed up by special tile bolted to the tubes. Behind the tile is a layer of insulating material held in place by steel casings.

Circulation is entirely free and complete. The tubes lead either to the boiler drums or to water wall headers. In the case of headers circulating tubes, connect them to the boiler drums. Down-comer tubes serve to return the water from the top of the wall that has not been evaporated into them. The headers are supported on steel springs which allow for ample expansion.

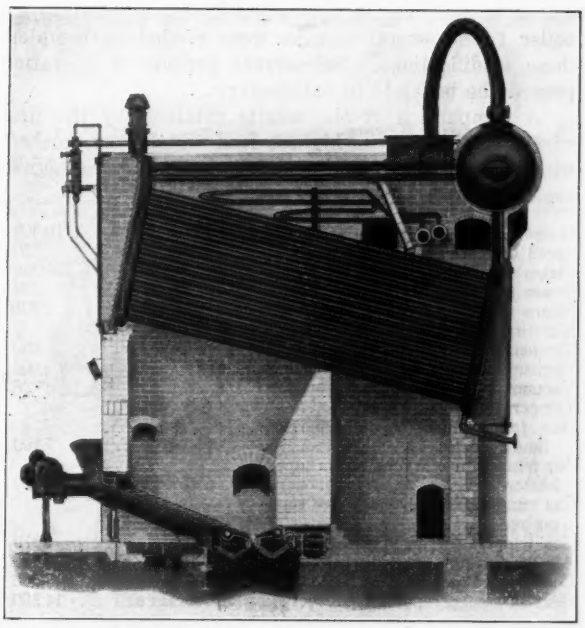


FIG. 3. NEW ERIE CITY CROSS DRUM BOILER DESIGNED FOR LOW HEADROOM

Statement by Erie City Iron Works, Erie, Pa.

Erie City Iron Works of Erie, Pennsylvania, has introduced a new cross-drum boiler in the past year that is an original development (patents pending) of interest to users of low headroom water-tube boilers. The use of a flat handhole sheet and the outward bend of the tube sheet are peculiarities of this new design. This method of construction permits all rivets to be driven hydraulically. Single seam construction prevents only one calking edge, an obvious reduction of leakage possibilities.

The single row of rivets, because of this unique bend, is protected from the hot fire and gas zones when boiler is in place. The method of suspending the front header is also unique and original in that no rivets in the hanger arrangement are in the water or steam space. The rivets holding the loops are driven through the top

of the handhole sheet which is extended above the top row of rivets. Thus another source of leakage is eliminated. The drum for this boiler is built in three diameters, 42 in. 48 in. and 54 in. and a wide selection of tube spacing assures the user a size of boiler to meet almost any horsepower requirement for this type of boiler.

Statement by the General Electric Co., Schenectady, N. Y.

In the South Meadow Station at Hartford (Conn.) the General Electric mercury-vapor power-plant equipment was operated during the year for several periods of two to three weeks' duration each; inspections of the apparatus being made after each operating period. The first runs, made in October and November, 1928, had shown the advisability of certain modifications in the mercury boiler. Due to the desirability of further research to improve the circulation of mercury within the boiler tubes several months were needed to complete these modifications. Subsequent periods of operation proved the boiler to be satisfactory.

A comparison of the results obtained by the unit when running at the highest load which was reached, with the results for which the equipment was designed are as follows:

Output of mercury turbine	10,000 kw.	10,300
Speed of mercury turbine	720 r.p.m.	720
Steam produced per hr	125,000 lb.	130,000
Steam pressure	350 lb. G.	270
Steam temperature	700 deg. F.	810
Mercury vaporized per hr	1,150,000 lb.	
Temperature mercury vapor	884 deg. F.	880
Pressure vapor at mercury turbine	70 lb. G.	68
Vacuum in mercury condenser	28 in.	28.5
Temperature mercury exhaust	458 deg. F.	
Gas temperature beyond mercury liquid heater	950 deg. F.	1,100
Gas temperature beyond steam superheater	650 deg. F.	720
Gas temperature beyond water economizer	480 deg. F.	
Gas temperature to stack	280 deg. F.	310
Air temperature entering furnace	390 deg. F.	400
Coal burned per hr	14,500 lb.	15,500
Heat in coal per pound	14,500 B.t.u.	14,300

These operating figures show that the efficiency of the mercury turbine is somewhat better than expected, also that the combustion conditions and heat transfers in the surface beyond the mercury boiler are also better than expected. The reduction of the gas temperature in the mercury boiler was materially less than was intended. This gas temperature has, however, been much reduced by the introduction of certain baffles which prevent bypassing and which force the heated gases to pass through the heating surface of the mercury boiler in a more effective manner than when the test data were taken. This change in baffling the boiler puts more heat into the mercury and thus improves the net economy.

Such steam as was made during trials, if used in the best large turbine apparatus and with the best methods of regenerative feed heating, would produce 14,000 kw. plus all necessary auxiliary power in addition to the 10,300-kw. output of the mercury turbine. There would thus be obtained 24,300 kw. from a consumption of 15,500 lb. of 14,300-B.t.u. coal per hour, or 9140 B.t.u. per kw-hr.

This equipment, while operating, makes a saving at Hartford of about $800 a day in fuel alone.

Six mercury-boiler units are installed in an oil refinery, the mercury vapor generated by them being used for refining oil. The highest mercury pressure used is 200 lb. gage, corresponding to a vapor temperature of more than 1000 deg. F.

Statement by the Union Iron Wks., Erie, Pa.

Most important of the developments made by the Union Iron Wks. during the past year has been in connection with the company's "N" Type boilers embodying the principle of radiant heat exposure.

These boilers, because of the arrangement of boiler heating surface and the exposure of more boiler tubes to direct radiant heat, have proved to be efficient boilers for high overload conditions, many installations having been made during the past year, operating records from them having borne out these facts.

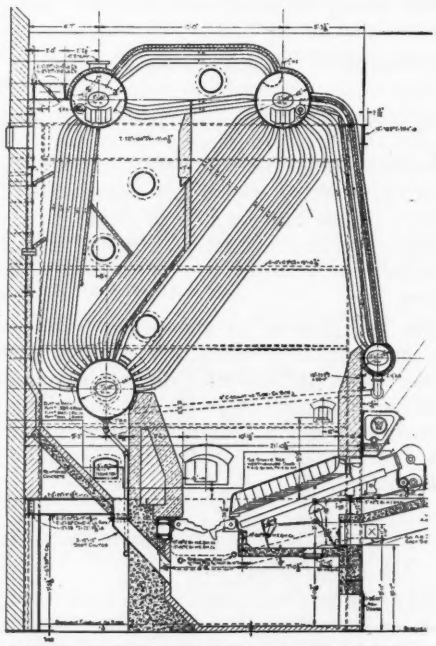


FIG. 4. UNION N TYPE BOILER AS INSTALLED AT THE LOVELL MFG. CO.

Statement by the Riley Stoker Corp., Worcester, Mass.

Among the newest developments of the Riley Stoker Corp. is the Riley-La Mont Water Wall, an entirely new water wall based on the theory of forced and controlled circulation of water and steam through the tubes. The company has made about six installations of this water wall during the past year.

Statement by the Superheater Co., New York, N. Y.

The Superheater Co. has installed or designed during the past year a number of Elesco superheaters in the high-pressure class that is 450 lb. and above.

Pressures and temperatures of the past year will be surpassed by Elesco superheaters now being designed for 1800-lb. pressure boilers for the Philip Carey Co. of Lockland, Ohio. These superheaters, in addition to being for the highest pressure in this country, are also

designed for the highest temperature, 825 deg. F., for integral superheaters in an industrial plant.

In the near future, the Northern Indiana Public Service Co. will install new 700-lb. boilers equipped with Elesco superheaters, designed for a final steam temperature of 775 deg. F. At the present time, designs and experimental work are being done on Elesco superheaters for varying high temperatures up to 1100 deg. F.

Capacities from individual steam generating units, due to modern firing method and the use of water walls, have made tremendous advances during the past year.

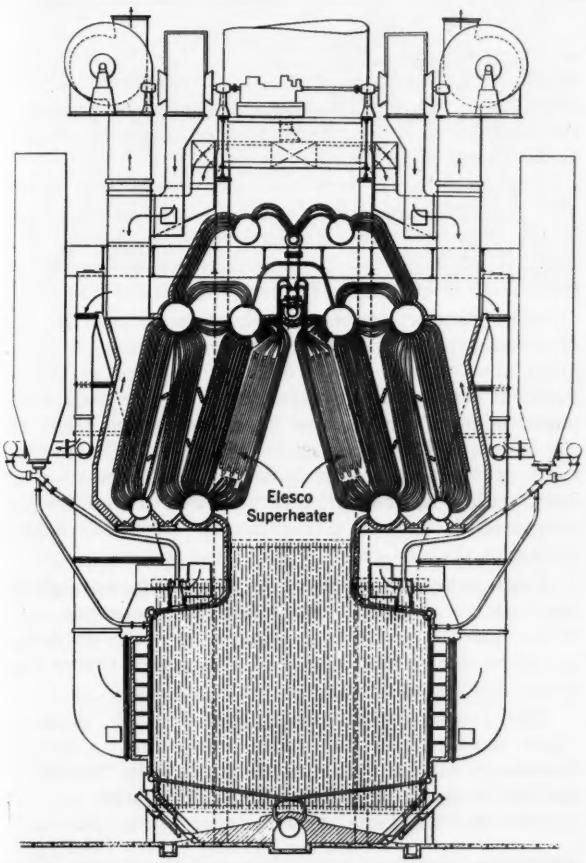


FIG. 5. BOILER ARRANGEMENT AT EAST RIVER STATION WHERE ELESCO SUPERHEATERS ARE DESIGNED TO HANDLE 1,000,000 LB. OF STEAM PER HOUR

This necessitates that superheaters for these boilers must handle an enormous amount of steam without undue pressure drop and also provide uniformity of superheat.

At the East River Station, New York Edison Co., the last of the three new double Ladd type boilers, equipped with Elesco superheaters, has just been put into operation. The superheaters are designed to deliver 257 deg. F. superheat (final temperature 725 deg. F.) to a maximum of 800,000 lb. steam per hour at 425 lb. pressure. Provisions have been made in the design to handle 1,000,000 lb. per hr. of steam, the reserve capacity of the boiler. Boiler and superheater are illustrated in Fig. 5. For this installation, we have developed built-on unit supports. This construction facilitated the superheater application and is expected to reduce support trouble.

We also developed a new design for the interdeck type superheater which was first applied to an installation at the Venice Station of the Union Electric Light & Power Co. In this design, Fig. 6, the saturated steam header is located behind a baffle, a sliding section of which permits free movement of the boiler with relation to the superheater. The superheated steam header is located outside the boiler setting.

Due to the high internal temperature of this header, it must be supported at several points and this can be more readily accomplished outside the boiler setting. The practical advantage from the standpoint of joint maintenance is obvious. For the company's interdeck-type superheater designs, this will be standard practice wherever a design permits of its application. As illustrated in this drawing, the eccentric header, which is initially forged from a solid billet, remains standard practice for high-pressure and high-temperature superheaters. With the eccentric header, the unit joints are

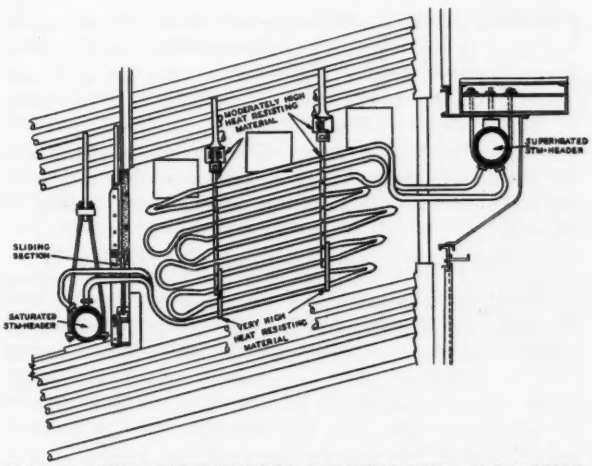


FIG. 6. NEW TYPE ELESCO SUPERHEATER INSTALLED AT VENICE STATION

located in the heavier wall to provide a uniform distribution of stress.

Elesco Water Walls

Elesco bifurcated water walls have been placed in service during the past year at the Bayway (N. J.) Plant at the Standard Oil Co. and have been giving very satisfactory performance. A previous installation of Elesco bifurcated water walls at the Kearny (N. J.) Station, Public Service Electric and Gas Co., is now established as a complete success and has given no operating or maintenance troubles.

To set the valves of a duplex steam pump, place the pistons midway of their extreme positions. The valves should be centrally located over the ports and with sufficient lap to just cover all five ports. The location of the valve can be varied by means of the nut or nuts on the valve steam. Lost motion should be the same on each side; this can be tested by moving the piston first to one extreme position and then to the other. This lost motion controls the length of stroke and the amount to allow must be found by trial;—in large pumps, it is adjustable but in small pumps, is usually fixed by the pump design.

New Stokers, Improved Pulverizers increase Boiler Room Efficiency

Developments in Stokers and Stoker Drives

STATEMENT BY THE DE LAVAL STEAM TURBINE CO., TRENTON, N. J.

COMPACTNESS, efficiency and reliability of worm gear is leading to its more extended use in power plants. For example, Fig. 1 shows De Laval Steam Turbine Co. worm reduction gears built into the drive of Taylor stokers. The worm gear ratio is 5 1/6 to 1 and the 3½-hp. d.c. motor is designed to operate at 400 to 1600 r.p.m. There is also available a 4 to 1 variation in the stoker, giving a total speed range of 24 to 1.

STATEMENT BY THE BROWNELL CO., DAYTON, O.

During the past year, the Brownell Co. has changed the stoker gear case, using a new principle of speed reduction and also eliminating the many oiling points that it previously had. It is now necessary only to watch one oiling point on the gear case which lubricates the entire stoker. The company has also introduced for what is believed to be the first time in the history of the art the use of dumping dead plates with a screw feed stoker. It is thought that this is the only stoker of this type that has this highly desirable feature.

STATEMENT BY THE JOHNSTON & JENNINGS CO., CLEVELAND, O.

A development with The Johnston & Jennings Co., in the stoker field during the past year has been the building of Stowe stokers with horizontal grate surface. Previous to this time, all Stowe stokers were built on a decided incline similar to many multiple retort underfeed stokers.

There are many cases where the company is better able to employ space available by the selection of one or the other of its two standard types of stokers. The modified form of the horizontal stoker is also being employed for burning coke breeze and anthracite fuels.

Of particular interest in each of these types are the improvements aiding it in building stokers of large grate area. Chain grates offer no problem as far as length is concerned but chain grates of very wide areas have presented a number of difficulties in the past. In the Stowe stoker, these are overcome by the employment of center frames which divide all stoker cross members into short lengths, each segmental length being supported at its two extremities by either the center frames or the side frame work of the stoker.

These intermediate or center support frames extend down to the building foundation and constitute one of the patented features of this equipment. It is the employment of a multiplicity of like narrow chains that makes this center frame construction possible.

The accompanying photograph, Fig. 2, shows a stoker employing 26 such individual chains. Only the framework of this stoker is shown but the two intermediate or center supports are well illustrated.

This also illustrates how the rear bridge plate and

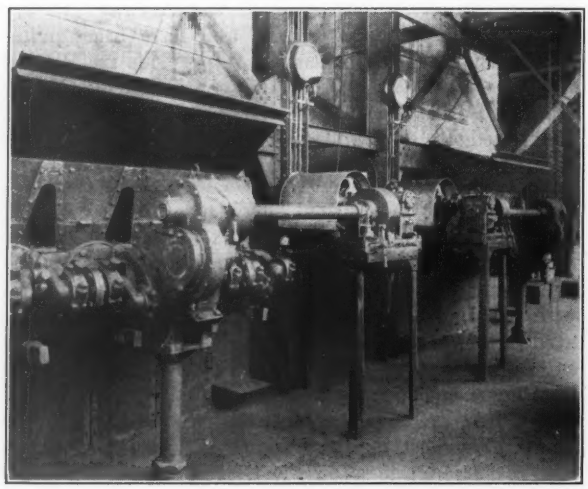


FIG. 1. DE LAVAL WORM GEAR USED FOR STOKER DRIVE

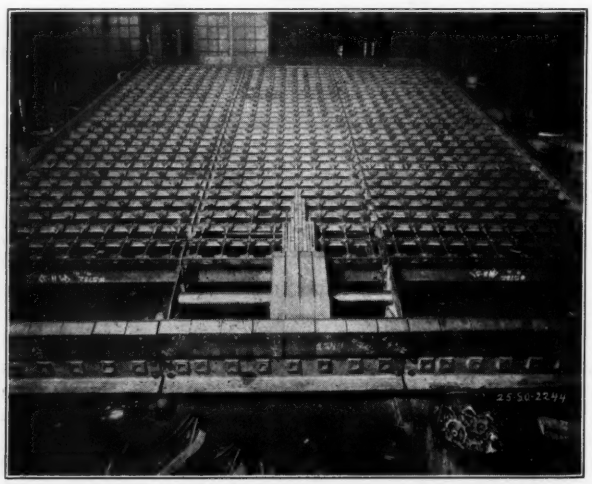


FIG. 2. ONE OF THE NEW HORIZONTAL STOWE STOKERS DURING ERECTION

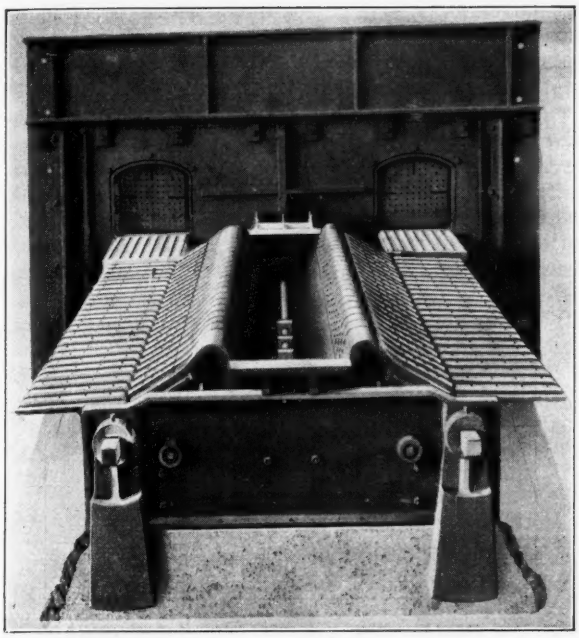


FIG. 3. McCLAVE-BROOKS CO., NEW TYPE SR UNDERFEED STOKER

rear shaft and all grate supporting members are built in short lengths laterally and carried by the major framework of side and center frames as described above. The air-tight rear housing and ash retarding cover plates (four of which are shown) are also clearly illustrated.

In this illustration, the stoker hopper and driving mechanism have not as yet been set in place on the shop floor and are not shown. This particular stoker contains 250 sq. ft. of active grate surface.

STATEMENT BY THE McCLAVE-BROOKS CO., SCRANTON, PA.

Newest development made by the McClave-Brooks Co. was the placing on the market of the new McClave Type SR (single retort) underfeed stoker which unit was placed on the market recently.

This stoker is intended for boilers from approximately 50 to 350 hp. and is designed for both mechanical and steam drive. It is also designed for unit or individual motor drive.

Many features in connection with this new stoker are distinctive in their class, such as the double worm reduction unit, the special design of tuyere plates or grate bars which lie between the main retort tuyeres and the ash dumps, and the extra heavy McClave sectional expansion stoker fronts with separate fire door frames bolted to the fronts so as to allow for expansion and contraction.

In addition to the foregoing, the company has applied for patents on its new and unique locking device for ash dumps as well as a new fire door locking device.

The counter-balanced ash dumps permit easy operation of the dumps when completely loaded or when idle and this is a distinct improvement.

STATEMENT BY THE RILEY STOKER CORP., WORCESTER, MASS.

The Riflex Mechanical Drive for Jones Stoker has gone through a development stage during the past year and it is now a much more refined product. The Riley Stoker Corp. has applied to this drive a regulating equipment which regulates both the coal and air to the stoker from a steam pressure regulator. This regulation is obtained with a constant speed motor by means of a special valve designed for us, therefore electrical regulation is not necessary.

Refinements Characterize Pulverizer Design Progress

STATEMENT BY THE AMERICAN PULVERIZER CO., ST. LOUIS, MO.

THE AMERICAN PULVERIZER Co. has added the type "S" series to its line of American Rolling Ring crushers, pulverizers and shredders.

This improved American Ring crusher consists of cast steel housings with sectional steel liners. All grinding parts, such as rings, grate bars, breaker and grinding plate, are of manganese steel. The main shaft is of select alloy-steel and carried on anti-friction tapered roller bearings mounted on heavily ribbed end castings. All parts are machined, therefore interchangeable.

Desired product is obtained by means of a patented eccentric adjustment in connection with the grinding plate. Like all American Ring crushers, this machine is protected from injury by tramp iron by the patented Rolling Ring principle of crushing. A tramp metal pocket for catching foreign material is optional.

The new series is made in a number of sizes. These crushers and pulverizers are particularly suitable for grinding all kinds of refractory materials and are especially adapted for reducing run-of-mine or lump coal to stoker or pulverizer sizes. Many large central stations and industrial power plants are using these crushers for this purpose.

STATEMENT BY THE ERIE CITY IRON WKS., ERIE, PA.

The most interesting development of pulverized fuel equipment in which the Erie City Iron Wks. has shared is that of the marine application of the Erie City Unitype Pulverizer to the West Alsek. The United States

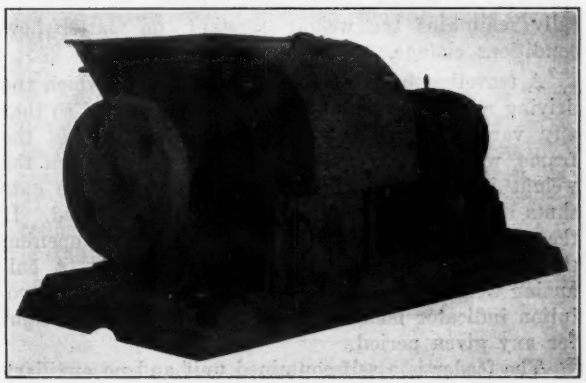


FIG. 1. NEW S SERIES AMERICAN RING CRUSHERS

Shipping Board designated the West Alsek for this trial because she represents the great majority of ocean-going freight ships in machinery equipment, speed and general makeup and is the type of ship that generally gives the owners the most concern in the reduction of operating costs.

It is interesting to note that the West Alsek is the first vessel ever to cross the Atlantic depending exclusively on pulverized coal for propulsion.

As a hand-fired job, this ship burned 464 lb. of coal per mile with a speed of 878 knots and 1790 hp. The coal was run of mine which cost $4.80 a ton trimmed and in the bunker. The cost per mile was, therefore, $0.994.

As a pulverized coal burning job, this ship burned 449 lb. of coal per mile with a speed of 9.58 knots and 2250 hp. The coal cost $3.81 per ton trimmed in the bunker. The cost per mile was, therefore, $0.763. To accomplish 9.58 knots an hour as a hand-fired ship would require 583 lb. per mile with $4.80 coal and the cost per mile would be $1.249. The actual saving in cost per fuel mile is shown to be 38.9 per cent. A saving of 59.5 hr. in traveling time from New York to Glasgow and Cardiff resulted on the first trial trip with pulverized coal.

Of the six varieties of coal burned, five were slack or duff grades which could not be used on a hand-fired ship to accomplish the economies which they achieved when pulverized. The West Alsek has completed two trips over and return and is soon to start its third trip over fired only by powdered coal.

Statement by the Grindle Fuel Equipment Co., Harvey, Ill.

During the past year, Grindle Fuel Equipment Co. has developed a small unit pulverizer having a capacity of 50 to 500 lb. of coal per hour. This machine includes a magnetic drum type feeder and has a blower built integral with the pulverizer. Coal and air regulations are very accurately controlled. The pulverizer, feeder and blower are all driven by one 7½-hp. motor. It is especially adapted to small boilers and furnaces of all kinds.

Statement by the Hardinge Co., York, Pa.

A regulating feeder, which eliminates variations in feed due to changes in size of material, moisture content and specific gravity, has been developed by the Hardinge Co. The Hardinge Constant Weight Feeder regulates by weight rather than volume. It automatically maintains the weight constant, no matter how conditions change.

A traveling belt, attached to a frame, on which the driving mechanism is also located, is suspended so that any variation in the weight on the belt moves the frame, which in turn moves the feed gate. When the weight increases, the belt frame lowers and the gate shuts slightly, thus reducing the quantity of feed. If the weight decreases, the belt and frame rises, opening the gate and increasing the quantity of feed. A balancing weight controls the quantity desired and a revolution indicator makes it possible to record the weight for any given period.

The feeder is a self contained unit and no auxiliary driving mechanism is required. The application of this

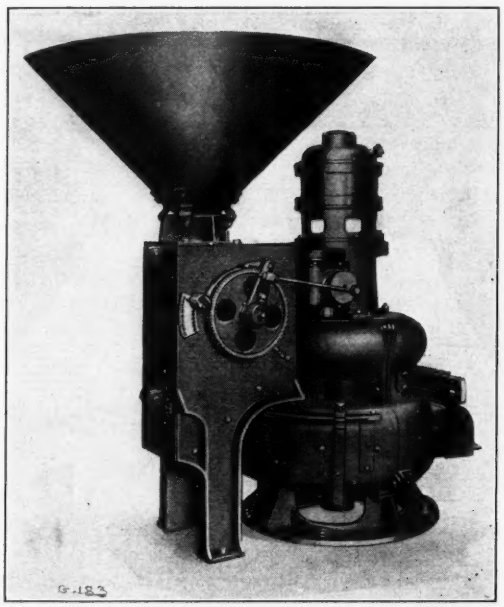


FIG. 2. SMALL UNIT PULVERIZER OF THE GRINDLE FUEL EQUIPMENT CO.

device is manifold. Several of these feeders set to deliver a constant weight of various materials make an excellent proportioning arrangement. By means of a control device, the feed can be varied at will any desired distance from the feeder itself.

This feeder will increase the average mill capacity at least 5 per cent over the volume method of feeding. Capacities range from 200 lb. an hour to over 100 t. an hour per unit.

Statement by the Kennedy-Van Saun Mfg. & Eng. Corp., New York, N. Y.

During the year, the Kennedy-Van Saun Mfg. & Eng. Corp. has perfected the Kennedy Air-Swept tube mill in its latest design, worm driven. The bearings of this pulverizer and housing of the worm gear are mounted on a heavy box section cast-iron base containing an oil reservoir. An oil pump, driven by the worm shaft, circulates oil from this reservoir through the pulverizer bearings and worm gears. Water cooling

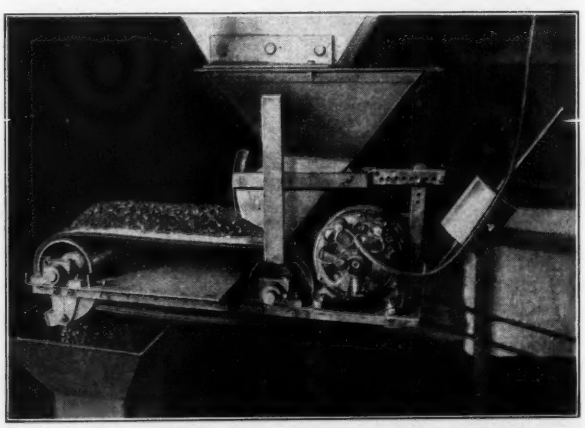


FIG. 3. CONSTANT WEIGHT FEEDER DEVELOPED BY THE HARDINGE CO.

is provided for the main bearings, thus permitting the use of preheated air through the pulverizer, drawing the hot air from ventilated tile walls of the furnaces. The oil in the reservoir is kept at required low temperature through the medium of a cooling coil.

While the worm drive is silent in action and void of vibration, which allows extremely quiet operation of the pulverizer, yet the manufacturer has added further improvement for the elimination of noise by the installation of patented sound deadening device, or noise insulating material, applied between the steel plate shell and the corrugated steel liners. In addition, a hair-felt sound deadening jacket is fitted to the exterior of the shell. The jacket is canvas covered, giving neat and cleanly appearance. This worm driven pulverizer is made in capacities of 1000 lb. of coal per hour up to 10 t. per hr. Beyond this the herringbone gear drive is used.

STATEMENT BY THE RILEY STOKER CORP., WORCESTER, MASS.

Most of the developments of the Riley Stoker Corp. on its coal pulverizer equipment have been in increasing

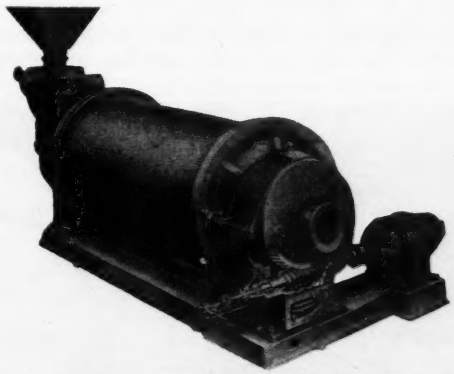


FIG. 4. WORM GEAR DRIVE APPLIED TO THE KENNEDY AIR-SWEPT TUBE MILL

the size of the pulverizers. During the past year, the company brought out what is known as its No. 4 Duplex Pulverizer having a rated capacity of 10,000 lb. of coal per hour and its No. 5 Duplex Riley Atrita Unit Pulverizer, having a capacity of 15,000 lb. of coal an hour.

STATEMENT BY THE STRONG-SCOTT MFG. CO., MINNEAPOLIS, MINN.

During the past year, the principal improvement in the Unipulvo unit pulverizer of The Strong-Scott Mfg. Co. has been the adoption of the under-feed principle for all sizes. There have, of course, been minor improvements in details as well.

There has been no change in the grinding principle which has been a unique feature of the mill from the start. The grinding in the Unipulvo is not due to direct action of the hammers. The hammers do not touch the coal and the rotor acts merely as a closed end fan moving a large volume of air, the air in turn moving the coal.

Classifiers used have been materially improved, consisting of a central uptake drum discharging into a stationary but adjustable impeller unit. This impeller unit translates the vertical velocity to a vortex action or centrifugal throw-out of the over-size which returns to the grinding chamber by gravity. The entire discharge from the rotor enters the classifier so that there is a removal of the finished product every time the material passes around the rotor.

The feeder consists of a reciprocating shoe on which the coal in the hopper rests. It is the full width of the grinding chamber and has an opening into it from 6 to 8 in. high. This eliminates any possible arching in the coal hopper and interruption of feed by any foreign matter in the coal or over-sized lumps. It makes possible a low down coal hopper which can be shoveled into where coal handling equipment is not available.

Rate of feed is controlled by the length of stroke of the feeder shoe. This can be regulated either manually or by connection to any standard automatic control device. In all mills from 2000 lb. per hr.

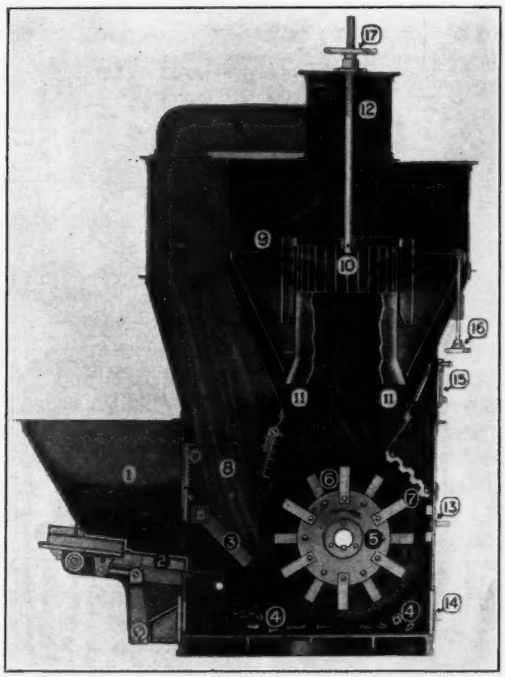


FIG. 5. THE NEW UNDER-FEED UNIPULVO

capacity and larger, there is also provided a set of oscillating "feeler bars" in the grinding chamber. These are interlocked with the feeding mechanism in such a manner as automatically to maintain a desired or predetermined coal level in the mill. It is, in effect, an automatic coal regulating device built into the pulverizer.

AT 32 DEG. F., the density of mercury is 13.5955 grams per cubic centimeter as determined by Kaye & Laby in 1918. Between 32 deg. F. and 110 deg. F. the mean cubical expansion is 0.0001010, while from 32 to 212 deg. F., it increases to 0.0001014. The factor for reducing inches of mercury to pounds per square inch is 0.4912 at 32 deg. F.; that is, one inch of mercury is approximately equal to ½ lb. per sq. in. a handy unit to use for estimates and approximations.

ENGINES and other machines are fastened to foundations by foundation or anchor bolts.

Dust Recovery Still of Prime Importance

THREE NEW DESIGNS PROVE THAT THE ELIMINATION OF DUST AND FLY ASH FROM FLUE GAS IS STILL THE SUBJECT OF MUCH INVESTIGATION

STATEMENT BY THE DUST RECOVERING & CONVEYING CO., CLEVELAND, O.

WHILE THE APPLICATION of The Dust Recovering & Conveying Co. Dracco high efficiency cloth filters to fly ash recovery has been discussed for some time, the first installations were not placed in operation before this year.

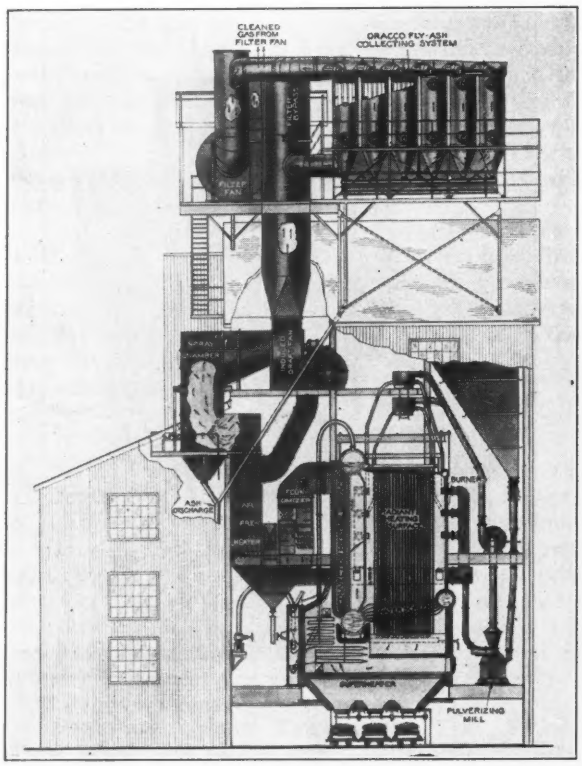


FIG. 1. INSTALLATION OF A DRACCO FILTER FOR FLY ASH ELIMINATION

In a small industrial power plant, the flue gas is drawn through a plate type preheater, used as a heat exchanger, and thus cooled to 240 deg. F., which is the maximum filter inlet temperature. The filters have completely eliminated any visible discharge from the stack even during soot blowing. The gas volume will not exceed 16,000 cu. ft. per min. at filter temperature.

Figure 1 is a partly sectioned elevation showing a Dracco filter installation on the steam generating plant of a steel company. In this case, the flue gas is cooled by the atomization of water into the gas stream, and the filter inlet temperature is maintained at 240 deg. F. by automatic thermostatic control. The filter equipment can be cut in or out without disturbing the furnace draft. The peak load is 150,000 cu. ft. per min. at 240 deg. F. The recovery will average over 8 per cent of the weight of coal burned.

STATEMENT BY THE GREEN FUEL ECONOMIZER CO., BEACON, N. Y.

Green's Dustrap, which has been developed primarily to meet the demand for a collector in plants burning powdered fuel, is the newest equipment of The Green Fuel Economizer Co. This apparatus is installed in the duct carrying the gas and the gas passes through it in a horizontal direction. The dust collecting units consist of a series of deeply corrugated barbed plates, freely suspended to form narrow vertical nozzles. The waved plates form alternately a nozzle and expansion chamber. In the passage through the machine, the dust in the gas is blasted against the barbed surface, to which it adheres through intimate contact and electrostatic attraction.

Casings are built in a rectangular shape and consist of steel plates with suitable supports and angles as stiffeners. The inlet and outlet openings are fitted with

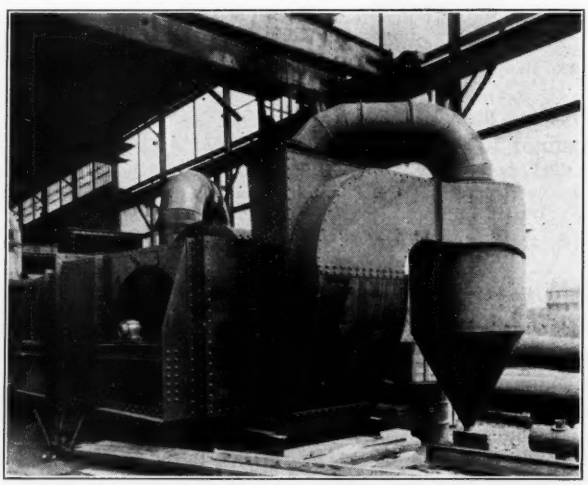


FIG. 2. ONE OF THE TYPE IV DUST RECOVERY FANS OF THE PRAT-DANIEL CORP.

structural shapes punched to suit the connecting flues. The hoppers into which the dust drops from the bottom of the plates are sectionalized to prevent gas from leaking through the hoppers at these points. This insures a construction which is rigidly braced in all directions.

Barbed and deeply corrugated sheets of copper bearing steel are supported by beams on the top structure of the machines and are held in place by spacers but are hung freely to provide the greatest vibrating effect from the rapping mechanism.

Under each row of units operating entirely enclosed in the dust bin is a drag chain which performs the double function of carrying the accumulated dust across the machine to the screw conveyor hopper and raising plates for rapping.

From the dust hopper, a screw conveyor sectionalized to prevent longitudinal leakage discharges the dust

through a sealed pusher screw which prevents any entrance of air or gas leakage at this point.

The top strand of the discharge chain is fitted with a wedge shaped link which engages projections on each plate raising and freely dropping them on the top support, which effectively shakes off accumulations of adhering dust.

An auxiliary damper operating chain, carried in synchronism with the rapping wedge, closes the gas off small sections of the machine during the rapping period, and opens the dampers again when the rapping is completed.

Under normal rated gas volumes, this device is designed to take out of the gas: 99 per cent of all dust particles which would be retained on a 50 mesh screen; 98 per cent of all dust particles which would be retained on a 100 mesh screen; 96 per cent of all dust particles which would be retained on a 200 mesh screen; 93 per cent of all dust particles which would be retained on a 300 mesh screen; as well as a large proportion of the finer particles depending on their size.

STATEMENT BY PRAT-DANIEL CORP., NEW YORK, N. Y.

An interesting development of the Thermix fan manufactured by the Prat-Daniel Corp. is known as the Type IV dust recovery fan.

The principle of operation of the Type IV Thermix stack, or induced draft fan without the stack is:

a. The concentration of the dust by means of a prolonged involute of the fan.
b. The continuous withdrawal of 5 to 15 per cent of the dust-laden gas.
c. The precipitation of the dust in a cyclone.
d. The return of the cleaned gas from the cyclone to the suction side of the fan.

This type of fan finds application in installations where the removal of dust and cinders is necessary to prevent these being distributed over the territory around the power plant and constituting a nuisance. The same type of fan may be used in many industries for the recovery of valuable dust which would otherwise be lost.

Feedwater Regulation, Valves and Traps

CONTROL OF FEEDWATER SUPPLY REGULATION AND EXCESS PRESSURE, VALVES AND TRAPS RECEIVES ATTENTION OF MANUFACTURER

STATEMENT BY THE BAILEY METER CO., CLEVELAND, O.

DURING THE PAST year, the Bailey Meter Co. has developed and placed on the market a thermo hydraulic feedwater regulator which embodies many new and improved features.

Figure 1 shows the regulating valve used in this new Bailey thermo hydraulic regulator; from this illustration, it will be noted that the valve is tight seating, has scientifically designed V-ports and is fully balanced. In operation, these features are intended to result in freedom from danger of flooding boilers at low rates of steaming or when on bank; smooth continuous feeding of boilers while in normal operation and a positive, non-chattering action of the regulating valve.

If seats must be reground or replaced, the entire valve cage can be removed from the Bailey regulating valve without removing the valve body from the line. The old cage, or a new one, can be replaced in the valve body with the assurance that all moving parts will be in perfect alinement, since the entire balanced valve mechanism is contained within the cage. This method of construction eliminates the necessity of removing the entire valve body and machining the seat after it has been installed, an operation that is necessary in certain types of regulating valves. Another interesting feature in this valve is the recessed rings in the valve cage immediately below the valve seat. The purpose of these recessed rings is to prevent cutting of seats and valve discs by wiredrawing at the tips of the V-ports. By means of these rings, the flow is evenly distributed so that equal wear occurs on all parts of the seat when the valve is operating near the closed position.

A lever and cam is provided on the regulating valve so that, in case it ever becomes necessary to regulate feedwater by hand, the regulating valve can be quickly opened by a half turn of the bypass lever. For installations where the valve will be located at a considerable distance above the operating floor, a sheave wheel is provided on the valve so that it can be bypassed by means of a cable operated from the operating floor.

New features which are incorporated in the Bailey thermo hydraulic generator, which is located at the boiler water level, are a cold water storage leg, a condensate bypass and a vacuum seal. The cold water storage leg, together with a large fin area on the generator tube, assures rapid condensation of steam in the annular space between the inner and outer generator tubes, which in turn results in positive closing of the regulating valve as the boiler water level tends to rise. Condensate which forms in the connecting piping between the generator and the boiler drum is returned to the boiler by means of the condensate bypass. This prevents erratic and false operation of the regulating valve which would be caused if the condensate were allowed to drain back to the boiler through the generator. The vacuum seal causes instantaneous closing of the regulating valve in case the boiler water level ever exceeds the upper limit of variation allowed by the generator.

Bailey thermo hydraulic feedwater regulators are furnished in all pressure standards up to and including 1350 lb.

There are no limitations as to where the regulating valve must be installed in the feed line, since only a hydraulic connection is necessary between the sylphon on the regulating valve and the annular space between the tubes of the generator. This connection is made by ⅜-in. O.D. soft annealed copper tubing as is shown in Fig. 1. As will be noted, the annular space between the outer and inner generator tubes, the copper tubing and the four-ply metal bellows or sylphon on the regu-

lating valve form an all-metal closed system. This system, because of its metal-to-metal ground joints, is practically leak-proof and seldom, if ever, must be refilled.

Another development for controlling the speed of steam-driven boiler feed pumps so as to maintain a con-

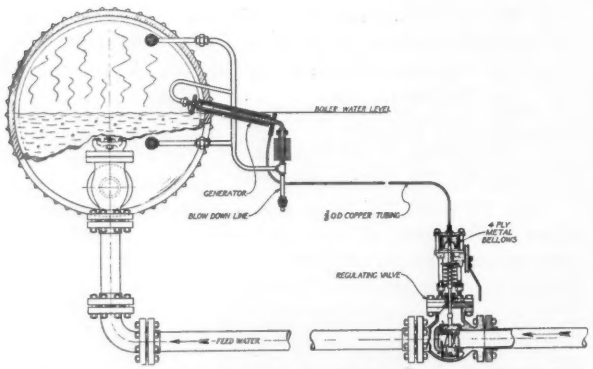


FIG. 1. BAILEY METER CO. THERMO HYDRAULIC FEEDWATER REGULATOR

stant excess boiler feedwater pressure, is illustrated in Fig. 2. The internal construction of these feed pump governors is also shown. The valve construction is fully-balanced, tight-seating and easily removable, and similar to that furnished with the Bailey thermo-hydraulic feedwater regulator.

This governor is installed in the steam line to the turbine or reciprocating engine which drives the feed-water pump. It will be noted that the spring and piston end of this governor hangs vertically downward from the steam line. This method of installation insures against the spring and piston being damaged by ex-

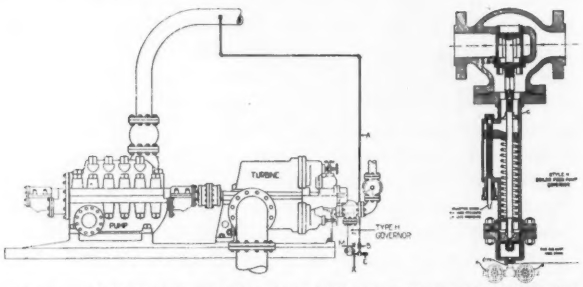


FIG. 2. BOILER FEED INSTALLATION USING THE BAILEY TYPE H GOVERNOR

posure to steam temperature. The feedwater pressure which is applied to the under side of the piston balances the steam pressure transmitted through the water seal surrounding the spring, plus the pressure exerted by the spring itself. The excess pressure in the feed water line can be regulated by adjusting the tension of the spring.

STATEMENT BY THE COCHRANE CORP., PHILADELPHIA, PA.

The Cochrane Multiport back pressure valve, in which a number of small disks are used instead of one large disk in order to reduce the weight and travel of the disk and to promote certainty of operation, has been widely and successfully used for a number of years.

The new feature which has been introduced by the Cochrane Corp. in this valve during the past year is that, in place of the ordinary dashpot located in the steam space formerly used, a vapor cushion chamber forming part of the valve disk itself is now employed. This chamber is inverted so that condensate does not collect in it, and depends for its action wholly upon the vapor or gas. It therefore works successfully with superheated steam or air, as well as with saturated steam.

General construction and arrangement of the valve give three different conditions of operation, namely, with the loading springs fully compressed, with the loading springs relieved so that the valve disks just touch upon their seats, and with the valves raised clear from their seats for free exhaust to atmosphere. Figure 3 shows the internal construction of the vapor cushion chamber. A small port, marked "A," is the only passage by which the steam pressure beneath the valve can enter the cushion chamber. The steam pressure, therefore, cannot act suddenly upon the valve, but only slowly as it flows through this orifice.

Similarly, when the steam has lifted the valve from

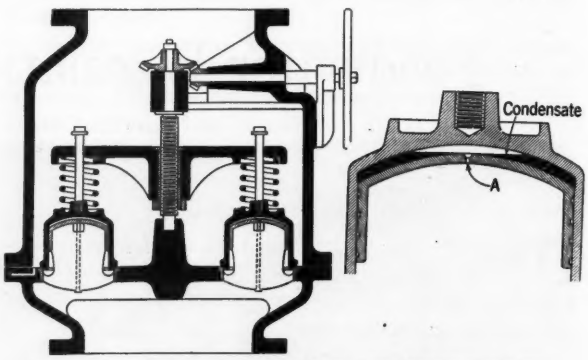


FIG. 3. THE NEW COCHRANE MULTIPORT BACK PRESSURE VALVE

its seat, the loading spring cannot return the valve to its seat suddenly with shock but only gradually as the steam escapes from the small orifice. At the same time, the steam pressure has full effect in lifting the valve since it progressively exerts its full force upon the whole area of the disk. In other words, the action of the valve is positive without any tendency to rattling, pounding or hammering. Only a small amount of condensate can be retained within the cushion chamber, where it serves to seal and lubricate the clearance between the valve chamber and the plunger. The cushion chambers, being inverted, do not collect grit and scale nor gum up with grease and oil.

STATEMENT BY THE JULIAN D'ESTE CO., BOSTON, MASS.

Among the new items developed by Julian D'Este Co. during 1929 have been the following:

The Curtis Excess Pump Regulator, Packless Type. Absence of packing, giving free movement to all working parts without tendency to stick or bind, is an important feature of this regulator. It is designed to control a reciprocating or turbine-driven steam pump so that a constant fixed excess pressure above the boiler pressure is maintained in the boiler-feed line. The regulator is installed in the steam-supply line to the pump, with the diaphragm chamber downward, and

this chamber is connected by a small control line to the discharge of the pump. In this way, the amount of steam passed through the valve to the pump is controlled directly by the pressure maintained on the feed line.

The valve bonnet, which extends from the valve body to the diaphragm chamber, is made long and ribbed to insure condensation at reduced temperature, being maintained above the diaphragm at all times when the valve is used with superheated steam.

An adjusting screw provides a ready means of varying the excess pressure to any value. The regulator is made in sizes of ½ in. to 3 in., inclusive.

The Curtis Type T return trap presents a new method of operating a return system by means of a pilot valve which is in turn controlled by the rising of the float in the body of the trap. It eliminates all oscillating units and has no levers or weights to distort adjustment. All valve movements are controlled externally. It is also featured by a packless type of float shaft and is noiseless in operation with no shocks or jars.

STATEMENT BY THE READING STEEL CASTING CO., BRIDGEPORT, CONN.

Following is a brief description of a new type of valve which the Reading Steel Casting Co. has developed during the past year. This consists of a new line of needle valves made from bar stock.

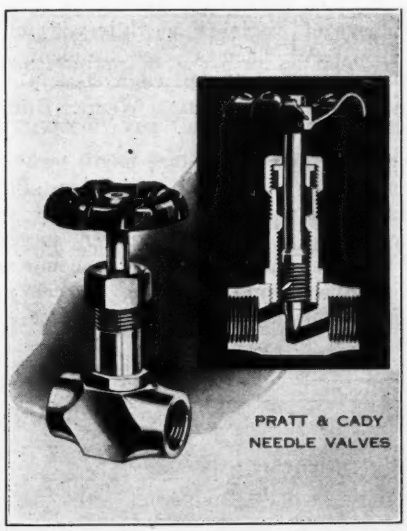


FIG. 4. NEEDLE VALVE MADE FROM BAR STOCK BY READING STEEL CASTING CO.

They are made either of 75,000 lb. per sq. in. extruded bronze rod, or stainless steel bar stock, according to the service required. The steel valves are particularly adapted to high temperature services and for use wherever bronze is corroded by the fluid being controlled, such as mercury or ammonia. They will stand terrific working pressures, yet they are extremely small and neat as compared to the usual high pressure valves marketed for similar services. They are made in sizes ⅛, ¼, ⅜ and ½ in. with regular female pipe thread connections, male union ends and S.A.E. flared union ends for use with copper tubing. They may be procured in globe, angle and cross types.

Since bringing out this line, the company has found many new uses for needle valves which have never been thought of before. They are replacing many installations of regular small globe and angle valves, owing to their ideal throttling qualities, great durability and low cost.

STATEMENT BY THE SWARTWOUT CO., CLEVELAND, O.

The most interesting development of The Swartwout Co. has been that of its variable differential pressure regulator, termed the Type SLP.

To provide good feedwater regulation, it is desirable, and in many cases absolutely necessary, to control accurately the differential pressure drop across the feedwater regulator valve. Where extreme fluctuations in boiler load are found, it is not merely sufficient to maintain a constant differential but the best results are obtained if a very low differential pressure can be provided for low ratings and this differential increased as required for the higher ratings.

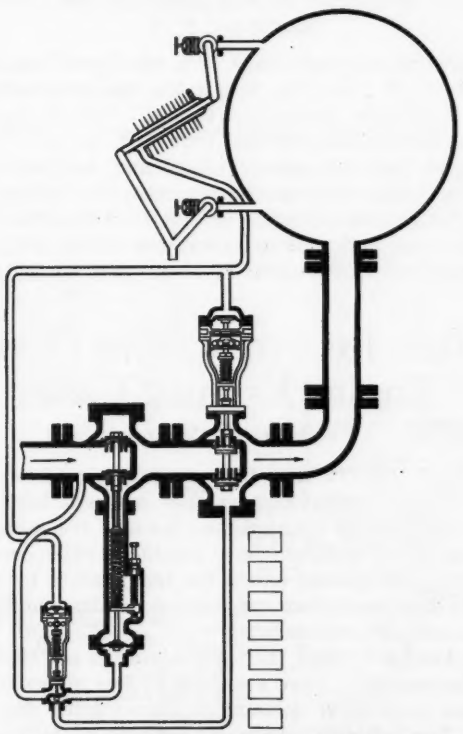


FIG. 5. CROSS SECTIONAL DRAWING OF THE SWARTWOUT CO. TYPE SLP EXCESS PRESSURE REGULATOR

This is successfully accomplished by the Swartwout Type SLP, illustrated in Fig. 5. A generator is located at the water level of the boiler. This can be the same generator that operates the S-C feedwater regulator. It is connected to the diaphragm of a small pilot valve, the motion of which controls the degree to which high-pressure boiler feedwater is admitted to the lower side of the diaphragm of the differential pressure valve.

At low ratings of the boiler, this generator pressure does not operate to the pilot valve and the lower side of the diaphragm of the differential pressure valve is connected into the feed line beyond the feedwater regulator. Under these conditions, there is a differential pressure maintained across the feedwater regulator

according to the adjustment of the spring in the differential pressure valve. This is set for the lowest possible pressure that will feed the boiler.

As the rating of the boiler increases, it is reflected by a slightly lower water level. This in turn generates more pressure in the generator and the pilot valve comes into operation. As it gradually opens, it admits high pressure boiler feedwater to the underside of the diaphragm of the differential pressure valve, thereby opening it, still further increasing the differential pressure across the feedwater regulator valve. As the rating on the boiler increases, this action proceeds progressively, until we have, if necessary, the entire pump discharge pressure available to put water through the feedwater regulator valve.

STATEMENT BY THE SARCO CO., INC.,
NEW YORK, N. Y.

Sarco steam traps have been partly redesigned by the Sarco Co., Inc., to permit the use of greatly improved spirally corrugated tubing. This tubing has been manufactured by the Sarco Co. as a result of extensive technical research work and the installation of new heat treatment equipment. The tubing now used for the manufacture of motor elements of Sarco steam traps and radiator traps has heavy wall, deep corrugations, and unusual resilience and elasticity.

Heat Recovery from Diesel Engine Exhaust Gases

BY DR. CARL COMMENTZ

HEAT RECOVERY from waste gases of two-cycle internal combustion engines has not, heretofore, been successfully accomplished because the mixing of scavenging air with the burnt products, which occurs in the two-cycle system, lowers the temperature to such a degree that waste-heat recovery under this condition is not practically attainable.

It has been found that this mixing is not thorough. On the contrary, there are, in fact, two approximately distinct consecutive columns of gases leaving the cylinder. The initial discharge is entirely of burnt gases under a higher pressure and under high velocity. This is followed directly by a mixture of a small portion of burnt gases with scavenging air under a lower pressure and hence at a lower velocity. The line of demarkation between these two columns is not definite, in fact, the difference is quite gradual.

Using this fact, Messrs. Sulzer of Winterthur, Switzerland, have developed a device which introduces an interruption in the outlet piping. The hotter gases, which have the higher velocity, pass by this interruption without being disturbed. As soon as the colder gases follow, there is a turbulence at the point of interruption and these gases having low velocity and little inertia follow the line of least resistance and go through the interruption to a branch piping.

It is possible to separate the gases by this device into two parts having considerable temperature difference. Generally the colder gases are discharged into the air while the hotter gases are used for heating in a waste heat boiler. Much of the heat of the colder gases may be utilized for other purposes.

New Award for Service to Engineers

IN THE FUTURE, the American Association of Engineers will endeavor each year to award the Claussen Gold Medal to the citizen of the United States, engineer or otherwise, who has, during the preceding year, performed the most distinctive service for the welfare of engineers, social or economic. It is to be awarded for engineering or scientific achievements only if they have served definitely and directly to promote the social and economic welfare of engineers. The first award will be made for services rendered prior to Jan. 1, 1930. The medal was designed by Elwyn Giles, and Amos Mazzolini is the sculptor. The personnel of the Committee that will make the award is as follows:

G. M. Butler, Dean, College of Mines and Engineering, University of Arizona, Chairman; L. W. Baldwin, President, Missouri Pacific Lines, St. Louis, Mo.; C. F. Kettering, General Director, Research Laboratories, General Motors Corp., Detroit, Mich.; R. B. von KleinSmid, President, University of Southern California, Los Angeles, Calif.; Arthur E. Morgan, President, Antioch College, Yellow Springs, Ohio; Michael J. Pupin, Physicist, Columbia University, New York City; W. J. Saunders, Chairman of the Board, Ingersoll-Rand Co., 11 Broadway, New York City; A. N. Talbot, College of Engineering, University of Illinois, Urbana, Ill.; J. W. Thomas, Vice-President, Firestone Tire and Rubber Co., Akron, Ohio; Geo. C. Warren, Chairman, Executive Committee, Warren Brothers Co., Boston, Mass.

Among the achievements that might make a person eligible for the award of this medal are: Publication of articles that impress the public with the value and importance of the work of the engineer; successful fostering of laws that may improve the economic and social status of engineers; public service of such nature as may bring engineers and engineering prominently to the attention of the people; successful direction of an organization devoted to the promotion of the welfare of engineers; creation of a nation-wide employment service for engineers or of a feasible plan for unemployment insurance, creation of a foundation to investigate the employment situation that now confronts engineers. Other activities will be found worthy of attention.

Nominations of persons to receive this medal are invited and should be sent to the chairman of the committee. They should include fairly complete biographies of nominees as well as a full statement of the services rendered which would seem to make them eligible for the award. While nominations made by individuals will be carefully considered, those offered by national, regional, state, or local groups will naturally carry more weight with the committee and are particularly invited. The first award of the medal will probably be made late next spring.

SOME PROGRESS has been made with reclaiming a portion of the heat of exhaust gases of internal combustion engines but, because of the high initial expense and cheap fuel, such systems have not as yet become overly numerous in this country. Some of the most successful waste heat reclaiming system are used by the navy for warming the fuel oil tanks.

Unit Heaters, Heat Exchangers Pipe and Pipe Tools Welding Equipment

CONTINUOUS BLOWDOWN, WASTE WATER HEAT RECOVERY FOR LAUNDRIES, COPPER BEARING STEEL PIPE AND MOBILE WELDER ARE SOME OF THE MORE RECENT DEVELOPMENTS

STATEMENT BY THE AMERICAN BLOWER CORP., DETROIT, MICH.

SO UNIVERSAL has been the demand for the Venturafin method of heating brought out by the American Blower Corp. in 1924 that it has been applied to a new series of unit heaters covering all possible applications.

Four such units are available, ranging from a slow speed unit equivalent to 125 sq. ft. of radiation to a 675-sq. ft. equivalent radiation high-speed unit using steam pressure up to 150 lb. per sq. in. gage.

STATEMENT BY THE CLARK TRUCTRACTOR CO., BATTLE CREEK, MICH.

A gas-powered self-contained welding unit was placed in production this year by the Clark Tructractor Co. The unit embodies a sturdy gas-powered truck

FIG. 1. MOBILE WELDING UNIT OF THE CLARK TRUCTRACTOR CO.

chassis enabling the machine to move under its own power to distant places for service. It has a General Electric 200-amp. generator which operates from the engine of the truck. It is also built with a larger engine and a 300-amp. G-E generator. This dual purpose Clark Trucwelder is designed for both production and repair service.

STATEMENT BY THE COCHRANE CORP., PHILADELPHIA, PA.

Another new development during the past year has been that of continuous blowdown equipment as illustrated in Fig. 2. Concentrated water is blown off continuously from the boilers through suitable needle valves

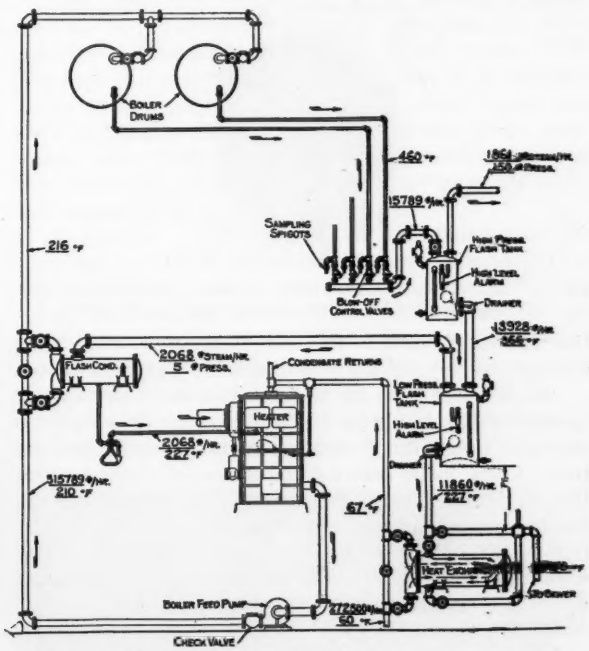


FIG. 2. COCHRANE BLOWOFF EQUIPMENT WITH HEAT RECOVERY IN THREE STAGES

into a flash tank wherein some of the heat of the blowdown water is utilized to produce steam or vapor which can be used for processes, feedwater heating and other purposes. The blowdown water then passes through a second low-pressure flask chamber wherein vapor is given off at a lower pressure for use in the open feedwater heater, after which the blowdown is circulated through a heat exchanger wherein the remaining heat is given up to the incoming cold feedwater makeup. The arrangement shown in Fig. 2 is intended for high-pressure boiler plants but various other simpler hookups can be used for lower pressure plants.

STATEMENT BY THE GRINNELL CO., PROVIDENCE, R. I.

Addition of several new sizes to the Thermolier Unit Heater and a development of a special unit for varying velocities which is particularly applicable to buildings with unusual ceiling heights have been made by the Grinnell Co.

Introduction of a Universal Forged Steel I-Beam Clamp, a few sizes of which will take care of all beam widths, and introduction of a 1350-lb. lap joint with Sarlun tongue and groove as well as other faces are also new developments.

STATEMENT BY THE NATIONAL TUBE CO., PITTSBURGH, PA.

The latest development of the National Tube Co. is a copper-steel pipe for all services in buildings, power plants, factories, bridges, marine, railway, mining and every industry where piping is exposed to atmospheric corrosion.

STATEMENT BY THE O. E. FRANK HEATER & ENG. CO., BUFFALO, N. Y.

The "O. E. F." Waste Heat Reclaimer for laundries, consisting of a series of units hung vertically into a concrete pit or steel tank, is the latest development of the O. E. Frank Heater & Eng. Co. The waste water from

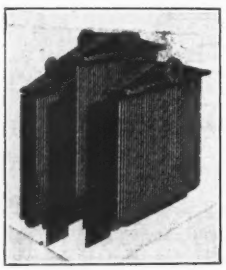


FIG. 3. SECTIONS OF THE O. E. FRANK HEATER & ENG. CO. WASTE HEAT RECLAIMER FOR LAUNDRIES

the washers flows into this pit, passing up and down, directed by copperized steel baffles or partition plates.

Clean water from the water softeners or city supply passes through the tubes of the Reclaimer, flowing from one unit to the other, making many passes in its long travel to the outlet before going to the hot water heaters. Up to this time, the water going to the hot water heaters has been at a temperature of approximately 50 deg. F., but with this new device the water will go to the hot water heaters at approximately 100 deg. F., depending upon the temperature of the waste wash water.

Tubing is made of heavy gage Admiralty metal, which is a special metal mixture. The tubes are bent into "U" shapes and both ends are tightly expanded into heavy metal tube sheets. The header section is made of cast iron.

It will be noted that the water flowing through the tubes is passing in opposite direction to the water flowing around the tubes, thus taking advantage of the counter-current principle—or the benefits derived from liquids in opposite direction.

Due to the constant flow of the water in the pit, it never becomes stagnant, as there is continuous circulation and no dead spaces can form.

With the "O. E. F." unit design, any one section of this reclaimer may be removed for cleaning or repairing

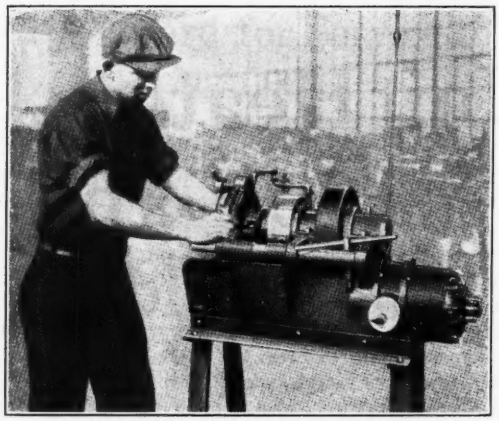


FIG. 4. NEW POWER PLANT PIPE THREADER OF THE TOLEDO PIPE THREADING MACHINE CO.

without interfering with the operation of the entire unit. It is necessary only to unbolt any one section and insert a distance piece where the section has been removed and proceed to operate the reclaimer as before.

STATEMENT BY THE SUPERHEATER CO., NEW YORK, N. Y.

The Superheater Co. has developed a new type desuperheater which will be immersed in boiler water at all times. Two of these desuperheaters are being placed in service at present.

STATEMENT BY THE TOLEDO PIPE THREADING MACHINE CO., TOLEDO, OHIO

Within the past year, the "Toledo" No. 999, ½ to 2 in., portable, power pipe machines has been developed by the Toledo Pipe Threading Machine Co.

This is a small machine developed for the power plant engineer and a large number of them are in use in power plants throughout the country.

Coefficient of Friction

PRACTICALLY ALL substances expand when heated and this expansion or change in volume is roughly proportioned to the difference in temperature. Accurate experimentation has established coefficient of expansion for many substances and these coefficients are listed in all mechanical handbooks either as the coefficient of linear expansion or as the coefficient of cubical expansion.

The effect of temperature changes can be calculated from the equations

$$L_2 = L_1 (1 + lt)$$

or $$V_2 = V_1 (1 + Ct)$$

where L_1 = length at initial temperature
L_2 = length at final temperature
V_1 = volume at initial temperature
V_2 = volume at final temperature
l = coefficient of linear expansion
C = coefficient of cubical expansion
t = temperature rise

The coefficient of cubical expansion is three times the coefficient of lineal expansion. They are really percentage factors, so that any units of length or volume can be used but it is necessary to know whether the coefficient is for degrees Fahrenheit or degrees Centigrade. Cooling results in a decrease in volume, in which case, for cooling t must be considered as negative.

Flow Meters, Control Equipment, Speed Changers

IMPORTANCE OF REMOTE AND CENTRALIZED COMBUSTION CONTROL, REMOTE CONTROL OF VARIABLE SPEED CHANGERS AND NEW APPLICATIONS OF SPEED REDUCES REFLECTED IN NEW EQUIPMENT

STATEMENT BY THE ALLEN-BRADLEY CO., MILWAUKEE, WIS.

BULLETIN 719 oil burner control panels are designed by the Allen-Bradley Co., to operate in conjunction with standard safety shunting controls where these oil burner controls lack sufficient current carrying

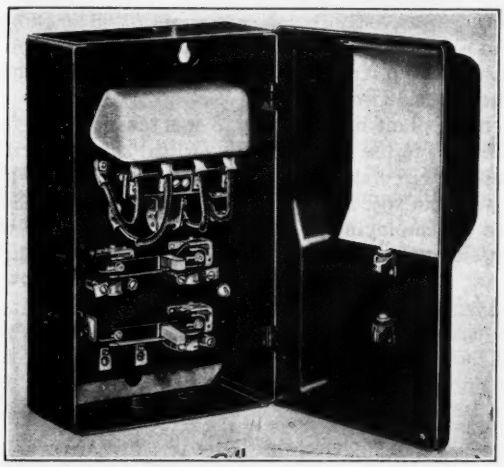


FIG. 1. ALLEN-BRADLEY CO. OIL BURNER CONTROL PANEL

capacity to switch the motor current. A magnetic switch starts motor when the thermostat makes contact, provided pressure switches, water gages, etc., are closed. If the oil burner fails to ignite, temperature relay stops the motor. Overload protection can be furnished. These starters are furnished for a.c. motors only. Ratings: Single phase, 1½ hp., 110 v., and 3 hp., 220 v.; polyphase, 3 hp., 110 v.; 5 hp., 220 v.; 7½ hp., 440-550 v.

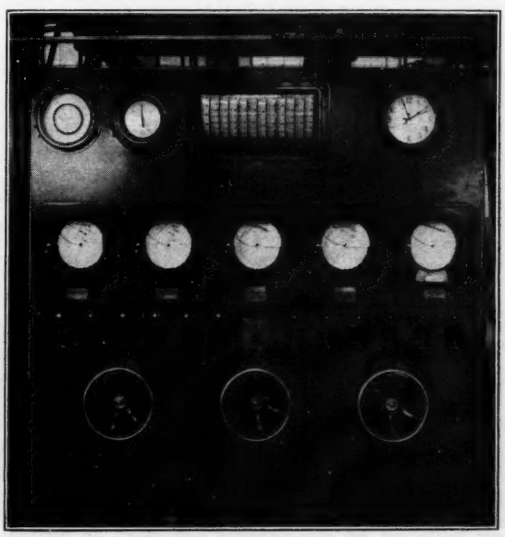


FIG. 2. BAILEY METER CONTROL PANEL AT LAKESIDE STATION

STATEMENT BY THE BAILEY METER CO., CLEVELAND, O.

As steam pressures and sizes of boilers increase, more and more metering equipment is necessary for the safe and economical operation of each boiler unit. In many of the newer plants, this equipment has been neatly arranged on a centralized boiler panel so that the operator may have before him at all times a picture of the prevailing conditions. Figure 2 is a photograph of the metering and control equipment, supplied by the Bailey Meter Co., for the new 1300-lb. boiler recently installed at the Lakeside Station of the Milwaukee Electric Railway and Light Co. Figure 3 shows the metering equipment for two boilers which are operated by automatic combustion control at the Charles R. Huntley Station of the Buffalo General Electric Co.

The important factors of boiler operation, steam flow air flow, feedwater flow, steam temperature, steam pressure and temperatures of flue gas and water at the entrance and exit of economizers are recorded for each boiler on this panel. Factors of secondary importance such as furnace draft, mill speed, uptake draft, economizer outlet draft, mill suction and secondary air pressure are indicated by Bailey multi-pointer gages which are located above the recording meters.

Feedwater meters installed on this panel are compensated so that integrator readings are independent of variations in feedwater temperature. The method by which boiler water level will be recorded and at the same time indicated on individual boiler panels and on panels in the pump room at the Holland Station of the New Jersey Power and Light Co. is shown by Fig. 4. As indicated in the figure, the boiler water level is recorded near the boiler drum and is transmitted by the

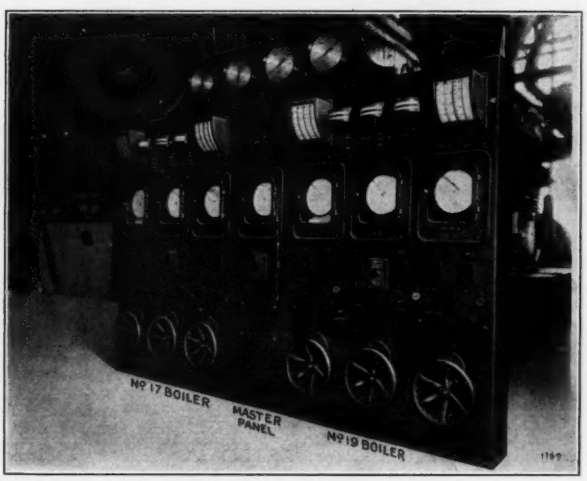


FIG. 3. BAILEY CONTROL PANELS AT CHARLES R. HUNTLEY STATION

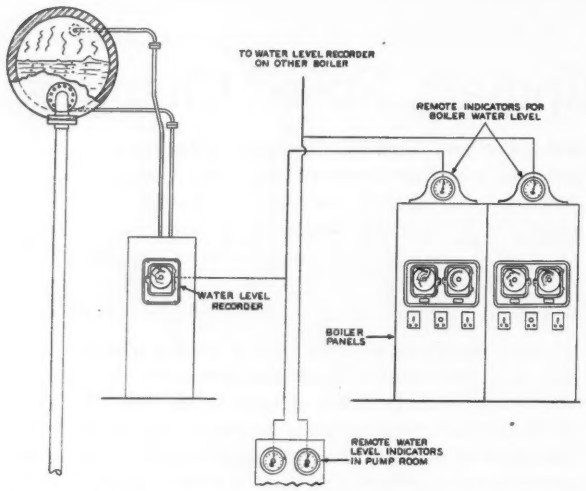

TO WATER LEVEL RECORDER ON OTHER BOILER
REMOTE INDICATORS FOR BOILER WATER LEVEL
WATER LEVEL RECORDER
BOILER PANELS
REMOTE WATER LEVEL INDICATORS IN PUMP ROOM

FIG. 4. THESE BAILEY INSTRUMENTS WILL INDICATE AND RECORD THE BOILER WATER LEVEL AT HOLLAND STATION

Selsyn system of long distance transmission to indicators which are located on the individual boiler panel and in the pump room.

STATEMENT BY THE DE LAVAL STEAM TURBINE CO., TRENTON, N. J.

Use of speed reducing gears in connection with steam turbine-driven, high-pressure centrifugal boiler feed pumps is a development of the De Laval Steam Turbine Co. In the interests of long life, reliability and low upkeep expense, it has been found desirable to design centrifugal boiler feed pumps for conservative rotative and peripheral speeds. In Fig. 5 the pump is designed to deliver 450 g.p.m. against 600 lb. pressure at 1750 r.p.m. while the De Laval velocity stage turbine runs at 5000 r.p.m. In other words, efficient turbine speed is conbined with a reliable pump speed.

A similar idea has been used quite extensively by the De Laval Steam Turbine Co. in the designing of centrifugal blowers and compressors for motor drive, as illustrated, for example, in Fig. 6, where a standard speed motor, running at 1750 r.p.m. drives a De Laval multi-stage centrifugal gas booster of 16,650 c.f.m. capacity against 7 lb. pressure through a De Laval double helical speed increasing gear.

Another piece of power plant equipment utilizing a De Laval worm reduction gear is the Andale self-cleaning rotary strainer shown in Fig. 7. The De Laval worm reduction gear is of the double reduction type and transmits 2 hp. from a 1160-r.p.m. motor. The ratio of reduction is 125 to 1.

In the plant in which Fig. 8 was taken, it was found convenient to use a slow-speed, vertical shaft centrifugal pump for circulating the condenser water, and to locate the variable speed motor high and dry in an accessible place by employing a De Laval 3 5/9 to 1 ratio worm reduction gear. The motor develops 40 to 55 hp. at

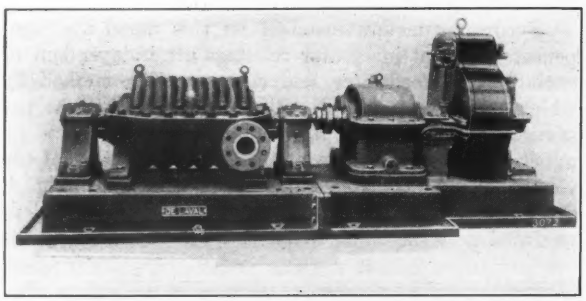


FIG. 5. DE LAVAL GEARS USED WITH HIGH SPEED TURBINE AND BOILER FEED PUMP

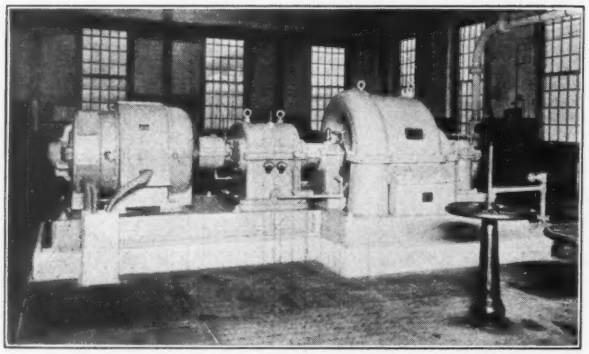


FIG. 6. DOUBLE HELICAL DE LAVAL GEARS USED FOR BLOWER SERVICE

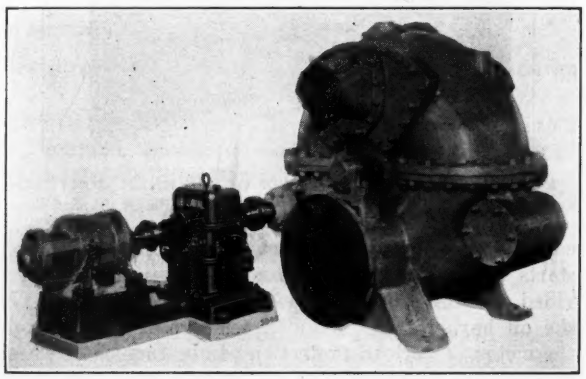


FIG. 7. DE LAVAL WORM REDUCTION GEAR DRIVING A ROTARY STRAINER

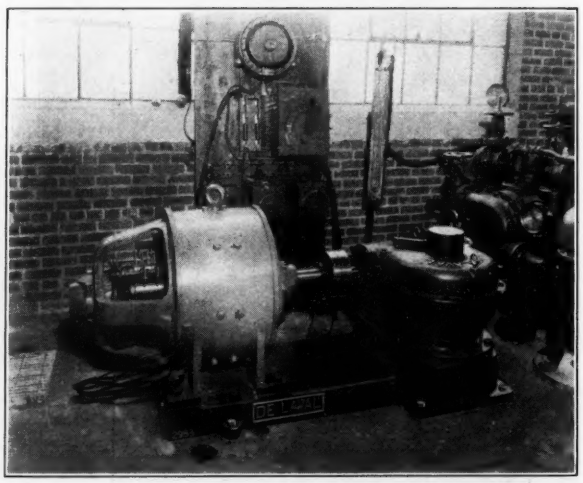


FIG. 8. DRIVING A VERTICAL CIRCULATING PUMP THROUGH DE LAVAL GEARS

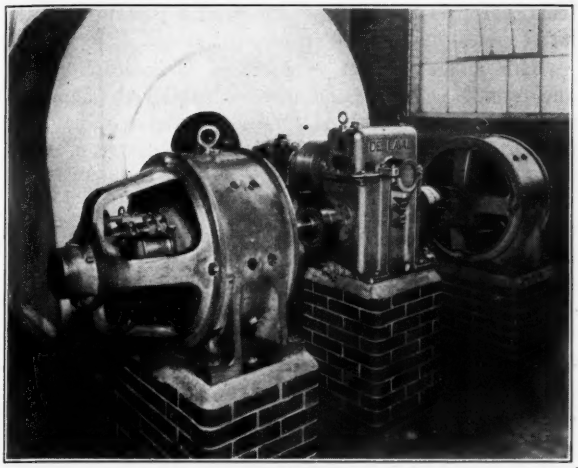


FIG. 9. USING DE LAVAL GEARS FOR A TWO-SPEED INDUCED DRAFT FAN

from 800 to 1600 r.p.m. according to the load and the temperature of the water, the speed being varied according to the turbine load and the temperature of the circulating water.

Figure 9 shows a De Laval worm reduction gear with the worm shaft extended at both ends so that the induced draft fan in the boiler room can be driven by either or both of the d.c. motors, which are so inter-connected electrically as to give high efficiency over a speed range from 600 to 1700 r.p.m. and a power range of 2½ to 55 hp. The gear ratio is 35⅞ to 1.

Statement by the Fisher Governor Co., Marshalltown, Ia.

Fisher Series 2200 control units have been developed by the Fisher Governor Co., to provide pressure regulators or pressure relief valves that would give excellent service under the most exacting conditions. They are intended for use where the pressure must be regulated within the closest limits and where the volume of steam being handled varies widely. As reducing valves or pressure regulators, they will give good regulation of the reduced pressure, even when the reduced or low pressure is almost as great as the initial pressure. In addition to these specific service conditions for which the Series 2200 specialties are intended, they are also applicable to those conditions where extreme pressures, temperatures and corrosion conditions are encountered.

Of particular interest to the power plant engineer will be the information that this control is especially well adapted for use as a makeup pressure regulator, where exhaust steam is being used for cooking, heating, or other process work. The Fisher Governor Co. is prepared to furnish the Series 2200 control for actuating both a makeup pressure regulator and an atmospheric relief valve by one interlocking control. For such service, varying initial pressures, and variable electrical and steam loads are satisfactorily met by a steady regulation of the back pressure on the turbine or engine.

Series 2200 units are auxiliary operated by an operating medium of either water or air. If it is convenient, lubricating oil from the turbine can be supplied under pressure for operating the specialty. These units can be provided with valve bodies in any pipe size and with practically any trimming to meet every installation condition.

Statement by The Foxboro Co., Foxboro, Mass.

The Foxboro Co. has built a steam flow meter, the design of the new meter being based on that of the Foxboro Orifice meter which has been extensively used for many years for the measurement of gas flow under field conditions where a rugged simple mechanism of high precision is necessary.

The new instrument is calibrated to read and record in terms of flow and is equipped with an integrator that reads direct, without multipliers, the total pounds of steam that have passed through the pipe. The integrator is a simple, accurate, dependable mechanism driven by an electric clock, or a spring-wound clock as preferred. Once each minute, it adds on the counter the number of pounds of steam that have flowed through the pipe during that minute. For example, if steam is flowing at a rate of 56 lb. per min., the integrator will add 56 to the total indication of pounds of steam. The chart reads direct in pounds per hour.

This new meter is fundamentally accurate because it is of a simple mechanical design in which friction is reduced to a minimum; a large, powerful float is employed, the motion of which is transmitted without angularity and because the steam coefficients were carefully determined by The Foxboro Co. after extensive research and experimentation covering a period of years. This program of research included a complete series of steam flow tests at the Massachusetts Institute of Technology.

Statement by the Reeves Pulley Co., Columbus, Ind.

The most important development by the Reeves Pulley Co., in connection with the Reeves variable-speed transmission during 1929 has been that of designing and perfecting automatic control. For many types of installations requiring variable-speed control, it is now possible to regulate the speeds, through the automatic

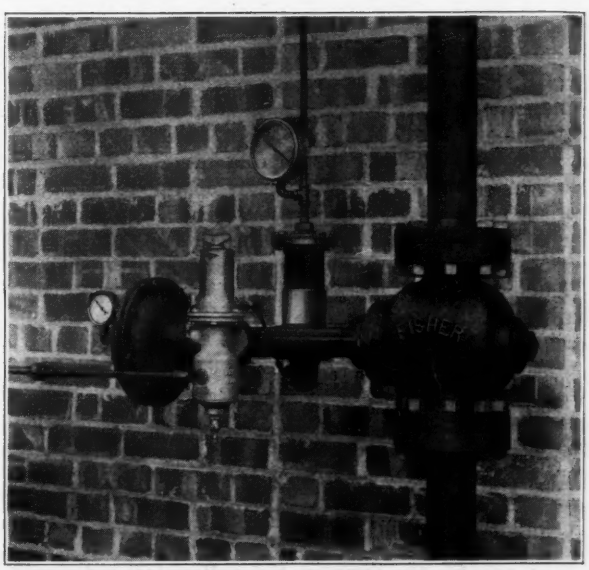


FIG. 10. THE FISHER GOVERNOR CO. SERIES 2200 PRESSURE REGULATOR AND RELIEF VALVE

design, so as to secure very accurate synchronization of speed between two or more production machines or pieces of equipment.

It is also possible to maintain predetermined results through the automatic type Reeves transmission. The automatic control of the Reeves transmission is so designed that it is possible to regulate the speeds automatically from pressure regulators, thermostats, indicating devices, moving carriages, or tool holders, combustion regulating equipment, floating rolls or other means of securing an indication to bring about predetermined results in production.

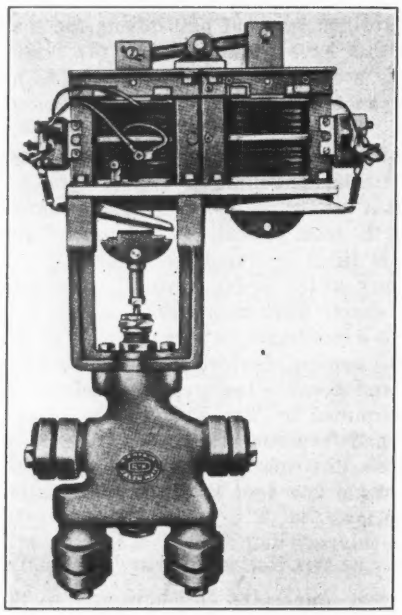


FIG. 11. FOUR-WAY, DOUBLE SOLENOID VALVE OF THE RUGGLES-KLINGEMANN MFG. CO.

In addition, the Reeves transmission has been made more compact and various designs are offered of an entirely enclosed type.

STATEMENT BY THE RUGGLES-KLINGEMANN MFG. CO., SALEM, MASS.

Chief among the developments of the Ruggles-Klingemann Mfg. Co. is the solenoid valve and its application to several special control applications.

The four-way solenoid valve has been developed for the remote control of hydraulically operated valves, and for pneumatic hoists and like service.

A solenoid trip valve has been developed for use in connection with fuel oil and natural gas-fired boilers. The object of this valve is to close off the fuel line on failure of the current supply, which operates the motor-driven fans.

Another development in solenoid valves has been what is termed a delayed action valve, in which a rapid movement of the solenoid produces a comparatively slow movement of the valve. This is a desirable feature, especially on water lines in preventing water hammer.

STATEMENT BY THE SIMPLEX VALVE & METER CO., PHILADELPHIA, PA.

In general, the Simplex Meter Register, redesigned in the choice of materials all to handle the general trend towards high temperatures and pressures is the latest development of the Simplex Valve & Meter Co.

This meter register is designed to indicate, record and totalize the flow, and there is employed in its construction, seamless steel tubing for the cylinder with forgings for the flanges. The primary device, or Venturi tube, utilized is also constructed of similar material.

As standard equipment with each Simplex venturi tube and meter register, there is furnished a new and improved manometer testing device, by which the meter register can be checked at any time while in service.

STATEMENT BY THE STEPHENS-ADAMSON MFG. CO., AURORA, ILL.

Wider application of the "JFS" variable-speed reducer, manufactured by Stephens-Adamson Mfg. Co. of Aurora, Ill., is made possible by the new electrical control designed by S-A engineers.

By simply pushing a "forward" or "reserve" button, operators can now increase or decrease the speed of conveyors or other machines for any capacity, without even leaving their desks.

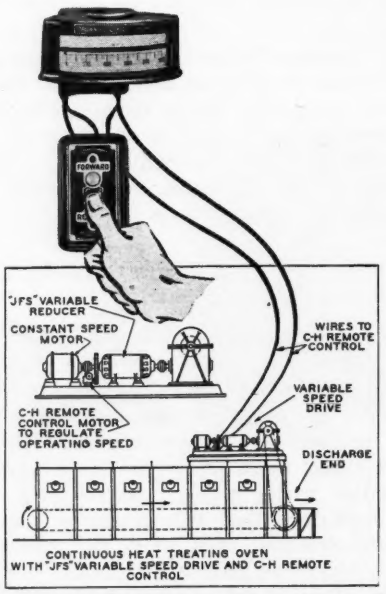

"JFS" VARIABLE REDUCER
CONSTANT SPEED MOTOR
WIRES TO C-H REMOTE CONTROL
VARIABLE SPEED DRIVE
C-H REMOTE CONTROL MOTOR TO REGULATE OPERATING SPEED
DISCHARGE END
CONTINUOUS HEAT TREATING OVEN WITH "JFS" VARIABLE SPEED DRIVE AND C-H REMOTE CONTROL

FIG. 12. STEPHENS-ADAMSON MFG. CO. JFS VARIABLE SPEED REDUCER WITH ELECTRICAL CONTROL

The "JFS" speed changer, driven by a constant speed motor, is used to drive various machinery units at different speeds which can be regulated by merely turning the hand wheel on the JFS unit.

Where the drive is accessible, this hand control is satisfactory, but when the variable speed drive is located in a crowded corner the speed regulation becomes difficult.

In this new push button control for the "JFS," the usual control hand wheel is replaced by a spur gear which can be driven backward or forward by a compact control motor mounted on the machine. The push button control box can be located at any distance from the drive and the speed increased or decreased by pushing the proper button until the desired speed is reached. When the right speed has been reached, the button is

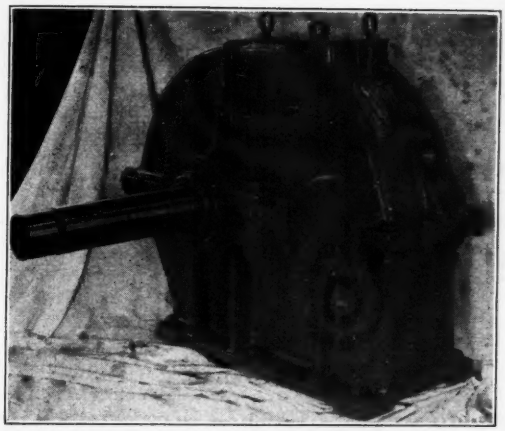


FIG. 13. ONE OF THE NEW WESTINGHOUSE SH SPEED REDUCERS

released and the rotation remains constant until a new speed is wanted.

With this new remote control, the output speed of a "JFS" unit driven by a 1200-r.p.m., 3-hp. motor, can be changed from 24 to 144 r.p.m., or vice versa, in slightly less than one minute.

Where the control push buttons are at a distance from the machine being regulated, an electrical generator type of tachometer is used to indicate the exact speed at which the machine is operating.

STATEMENT BY THE WESTINGHOUSE ELEC. & MFG. CO., PITTSBURGH, PA.

One of a new line of horizontal type speed reducers recently developed by the Westinghouse Elec. & Mfg. Co. is shown in Fig. 13.

Using Nuttall single helical gears and roller bearings throughout, the new line represents a valuable addition to the line of industrial equipment. A unique bearing assembly on the low-speed shaft takes care of overhung loads and external thrusts as well as permitting shaft expansion.

This line ranging in ratio from 2.8 up to 9.5 to 1 and in horsepower from 5 up to 600, is available with or without outboard bearings and with a distinctive design of welded bedplates.

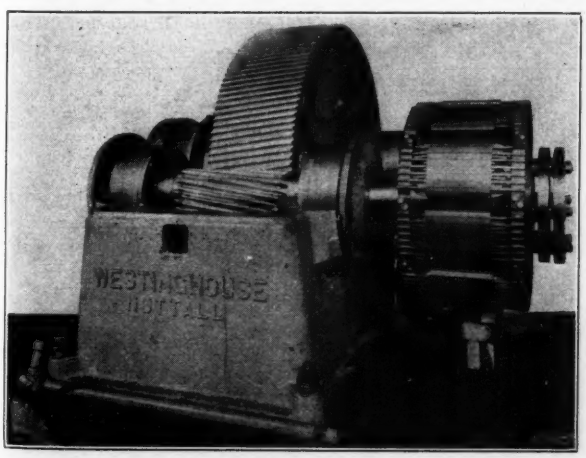


FIG. 14. WESTINGHOUSE COMBINATION MOTOR AND GEAR UNIT

Figure 14 illustrates another new design principle, that of overhanging the motor parts on the gear unit. All roller bearing construction, with a stiffness of shaft capable of maintaining the proper air-gap in the motor has resulted in a very satisfactory drive. The ability to build such equipment for severe rubber mill service conditions, accompanied by savings in space and elimination of coupling and motor bearings, points toward extended development along these lines.

Edison Medal Awarded to Charles F. Scott

EDISON MEDAL of the American Institute of Electrical Engineers has been awarded to Professor Charles F. Scott, New Haven, Conn., "for his contributions to the science and art of polyphase transmission of electrical energy."

The Edison Medal was founded by associates and friends of Thomas A. Edison, and is awarded annually for meritorious achievement in electrical science, electrical engineering, or the electrical arts, by a committee consisting of 24 members of the American Institute of Electrical Engineers.

Charles F. Scott, professor of electrical engineering at Yale University, was born at Athens, Ohio, September 19, 1864. His collegiate education was received at Ohio University in Athens, the Ohio State University, Columbus, from which he graduated in 1885 and Johns Hopkins University, where he engaged in graduate study for about one and one-half years, at the same time teaching in the Baltimore and Ohio Railroad apprentice school.

In 1888, he entered the testing department of the Westinghouse Electric & Manufacturing Co., in 1897 was appointed chief electrician, in 1904 consulting engineer of the company and in 1911 to his present position at Yale University.

During his connection with the Westinghouse Company, he was a pioneer in high voltage transmission of power and in the development of several types of equipment, including induction motors and transformers. The Scott or T- transformer connection which he devised in 1894 for transformation from two-phase to three-phase or vice versa has borne his name. From observations during the testing of insulators he predicted corona loss between high tension wires which he measured in laboratory tests in 1895, inaugurating the investigations in this field by others.

Professor Scott, now an honorary member of the American Institute of Electrical Engineers, has been a member since 1892, and was president during the year 1902-03. He has served many Institute committees, and is at present a member of the Lamme Medal, and Student Branches Committees, and representative on the Commission of Washington Award and The American Engineering Council.

His advocacy of the erection of a building for headquarters of the national engineering societies led to the receipt of the gift from Mr. Carnegie which made possible the culmination of his ideas in the Engineering Societies Building. He was a member of the conference committee of the national societies that formulated plans for the Federated American Engineering Societies, now American Engineering Council, and has served this organization continuously as an Institute representative.

New Applications Increase Popularity *of* Industrial Steam Turbines *for* All Services

STATEMENT BY THE DE LAVAL STEAM TURBINE CO., TRENTON, N. J.

DURING THE PAST year, the De Laval Steam Turbine Co. has developed a line of variable speed steam turbines for paper mill drives. Figure 1 shows a 350-hp. machine for a speed variation of 150 to 600 r.p.m. on the gear shaft. The turbine is a high efficiency turbine of the velocity stage type, running at 5000 r.p.m. This line of turbines is designed for steam pressures up to 400 lb. and for steam temperatures up to 725 deg. F.

Figure 2 shows a high, efficiency geared turbine designed for fan and generator drives, to operate on high steam pressures and temperatures. The turbine runs at 10,000 r.p.m. and is of all steel construction. The particular unit shown is a 150-hp. machine designed for 375 lb. steam pressure, 200 deg. F. superheat. Both this turbine and the turbine shown in Fig. 1 are designed primarily as noncondensing machines.

A high-speed condensing machine, the turbine running at 10,000 r.p.m. and the gear shaft 1200 r.p.m., is shown in Fig. 3. This particular type of turbine and gear is used primarily for driving generating and pumping equipment. Very high efficiencies are obtained, due to the refinements in turbine design and the speed at which the turbine rotor operates. The reduction gears are of our standard double helical De Laval type. The particular turbine shown is rated 450 hp.

Figure 4 shows a turbine-driven pumping unit for industrial plants. The turbine is a condensing turbine operating at 8000 r.p.m. This turbine is equipped with an improved type governing arrangement, in which no levers are used, all the control being effected hydraulically.

An interesting development which has recently occurred in the gasoline producing plants, is illustrated by Fig. 5. In one oil refinery, for example, the De Laval velocity stage steam turbines develop 150 hp. each at 2600 r.p.m. when receiving steam at 140 lb. g. and exhausting against 30 lb. back pressure to the process. Each turbine drives two pumps, a three-stage pump which delivers 500 g.p.m. of 0.75 specific gravity lean oil at 300 deg. F. against 240 lb. while the single-stage pump delivers 540 g.p.m. of 0.8 specific gravity rich oil at 100 deg. F. against 85 lb. per square inch.

In other words, where pumps and turbines operate together on a single process they can be combined in such a way as to be substantially self-regulating. This point is brought out even more forcibly in Fig. 5 where a single turbine drives four pumps operating together on an absorption unit. The De Laval velocity stage turbine runs at 2700 r.p.m. and the pumps driven by it include an 8-in. pump supplying 1000 g.p.m. of water against 70 ft. head; a 2½-in. pump handling 185 g.p.m. of 0.81 specific gravity rich oil against 55 lb. and a 2½-in. pump handling 60 g.p.m. of 0.8 specific gravity reflux gasoline against 20 lb. The same plant contains two other duplicate De Laval units.

We also find that the steam turbine driven centrifugal compressor is displacing the reciprocating compressor for blowing blast furnaces and bessemer converters, much as the geared turbine centrifugal pump

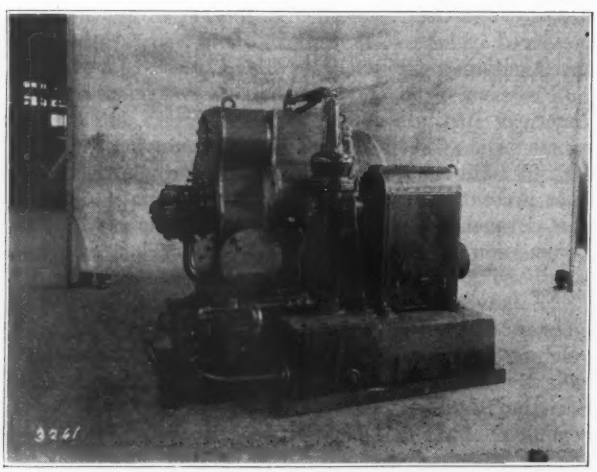


FIG. 1. ONE OF A NEW LINE OF VARIABLE SPEED DE LAVAL TURBINES

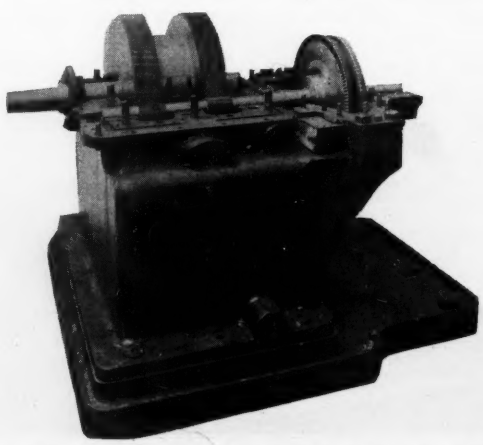


FIG. 2. NEW DE LAVAL GEARED TURBINE FOR BLOWER DRIVE

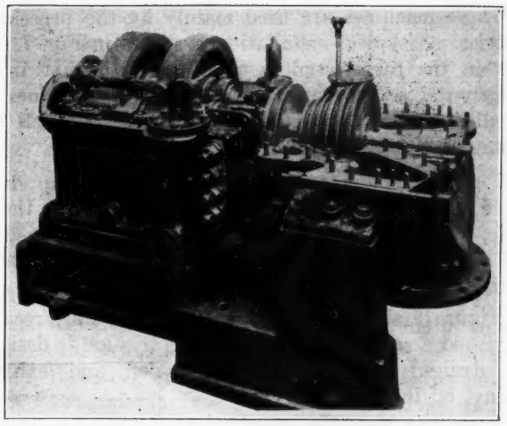


FIG. 3. A 10,000-R.P.M. DE LAVAL CONDENSING TURBINE

displaced the triple expansion pumping engine in water works supply stations. Figure 6 shows one of two De Laval blast furnace blowers installed in the plant of a large steel company in the middle west. Each unit is rated at 60,000 c.f.m. of air per minute against 30 lb. pressure at 2800 r.p.m. Another unit, rated at 115,000 c.f.m. against the same pressure is now being built and is believed to be the largest blast furnace blower ever contracted for.

Statement by the General Electric Co., Schenectady, N. Y.

Higher economies and wider applications were the outstanding results of developmental work on General Electric Co. industrial-type turbines. There was a definite demand for higher-speed turbines to meet the high speeds of such driven equipment as compressors and for improved economy in the lower-speed range of such equipment as pumps, in which case the new higher-speed turbines were geared to the pumps.

Five turbines were provided with casings of welded steel plates instead of castings. The advantages of the welded construction include greater flexibility in laying out the proper number of stages for the energy ranges encountered, more homogeneous material in the casings, and lighter weights.

In some cases, central stations applied turbines to heating plants and to the development of power and steam for industrial customers. An interesting example

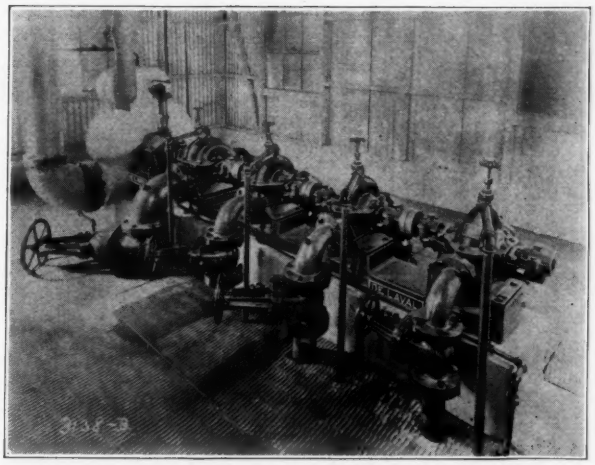


FIG. 5. DE LAVAL TURBINE DRIVING FOUR PUMPS IN A GASOLINE PLANT

of this consists of a 6000-kw. unit which is operated in parallel with a central-station line and furnishes part of the power and steam at three pressures for an industrial customer. The turbine consists of a non-condensing, automatic-extraction unit from which steam is extracted at two pressures. The pressures in these extraction stages are maintained by internal valves in the machine, regulating the flow to the subsequent stages.

Exhaust pressure is maintained by a back-pressure governor; the speed of the unit being held constant by a tie-in with a large 60-cycle system. Provision was made so that if a disturbance occurs on the line connecting the unit with the power system, and the frequency starts to fall off appreciably, the turbine is changed over to speed governing. The pressures at the extraction points are maintained and the excess steam, if any, is exhausted to atmosphere until the fault has been corrected.

A number of industrials having existing boiler plants at pressure around 150 to 200 lb. required increased power without increased steam and, to meet this condition, put in 400 and 600-lb. boiler plants, installing large-flow noncondensing turbine units between these higher pressures and the original equipment.

A large paper mill adopted a cross-compound unit consisting of two 7500-kw., 3600-r.p.m., noncondensing

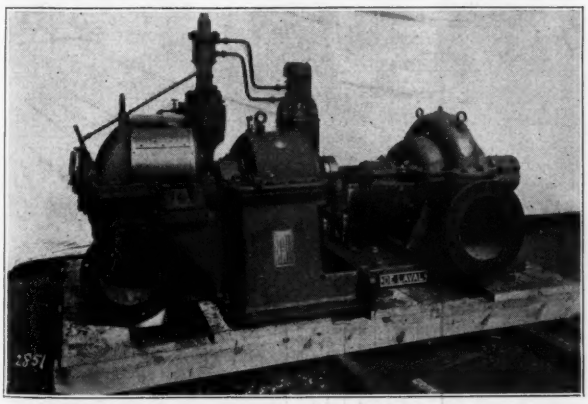


FIG. 4. HYDRAULIC GOVERNOR AS USED ON AN 8,000-R.P.M. DE LAVAL CONDENSING TURBINE

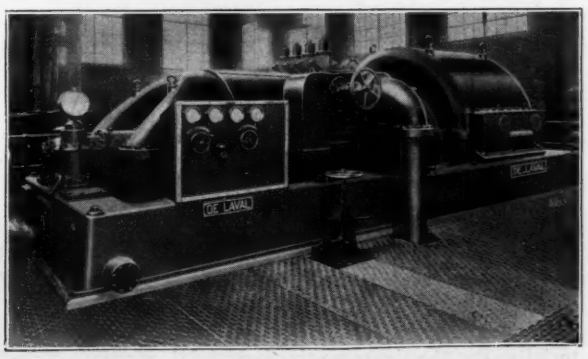


FIG. 6. STEEL MILL BLOWER DRIVEN BY A DE LAVAL TURBINE. A SIMILAR UNIT NOW UNDER CONSTRUCTION RATED AT 115,000 C.F.M., IS BELIEVED TO BE THE LARGEST EVER CONTRACTED FOR

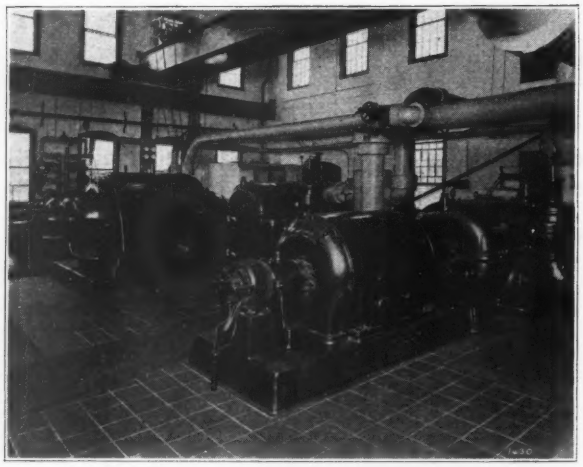


FIG. 7. TYPICAL TERRY BLEEDER TURBINE IN A PAPER MILL

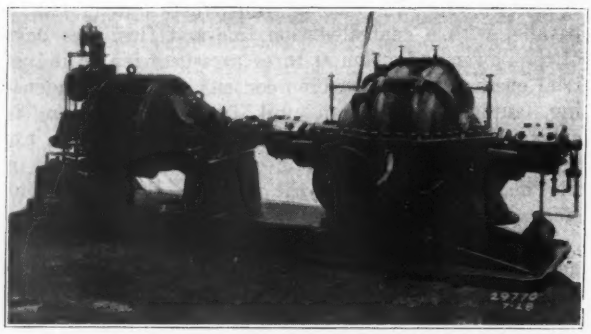


FIG. 8. 450-LB. TERRY TURBINE PUMP DRIVE

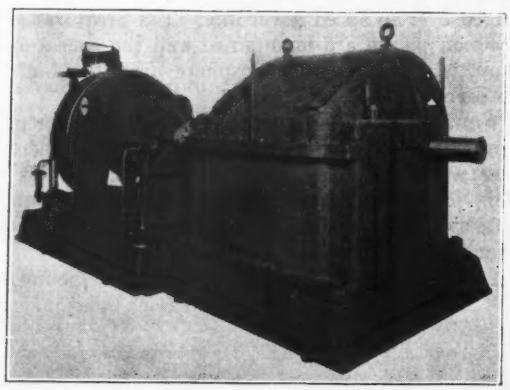


FIG. 9. GEARED TERRY UNIT BUILT FOR A SALT MANUFACTURER

sets operating from 600 lb. to 15 lb. gage with cross-over pressure in the neighborhood of 200 lb. Steam is bled from both turbines and from the cross-over for feedwater heating and process work.

STATEMENT BY THE TERRY STEAM TURBINE CO., HARTFORD, CONN.

The Terry Steam Turbine Co. find that the use of steam turbines in the sizes from 5 to 2000 hp. is materially on the increase in industrial plants. There seems to be an increasing tendency to employ special turbines correctly, that is units designed throughout for the plant conditions.

These machines are used mainly by the process industries. A typical installation is shown in Fig. 7. The unit in the foreground is a 500-kw. and that in the background a 1000-kw. machine. These machines are installed in an Eastern paper mill and furnish bled steam at 40 lb. pressure for drying purposes.

Figure 8 shows one of four 1700-hp. pump drives which have been installed recently by Lazote, Inc. of Belle, W. Va. The turbine in this case is designed for 450 lb. initial, and 10 lb. back pressure. The exhaust steam is, of course, employed for process heating.

Figure 9 shows a 1500-kw. turbo-gear unit recently furnished a salt manufacturer. The turbine is designed for straight noncondensing operation and exhausts against 80 lb. back pressure.

A typical Terry turbine paper machine drive unit is shown in Fig. 10. This is an 85-hp. machine which drives the variable speed line shaft through a Terry reduction gear and chain drive. Another installation is shown in Fig. 11, one of three units furnished the International Paper Co. for their Mobile, Ala. mill. The unit in this case is rated at 400 hp. and is direct connected to the variable speed shaft.

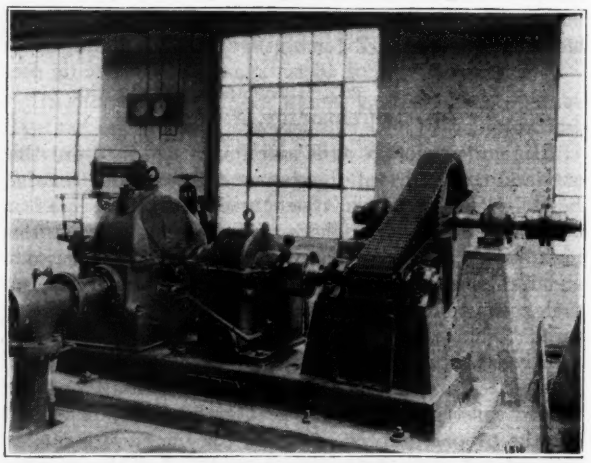


FIG. 10. AN INTERESTING TERRY PAPER MACHINE DRIVE

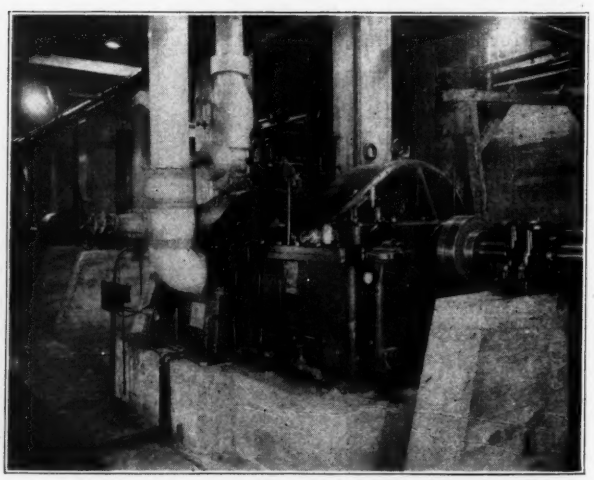


FIG. 11. A RECENT TERRY INSTALLATION AT THE INTERNATIONAL PAPER CO.'S MOBILE MILL

Transformer and Generator Developments

Non-Resonating Type Transformer Proves Popular from the Start

Statement by the American Brown Boveri Co., Inc., Camden, N. J.

DURING THE PAST year, the American Brown Boveri Co., Inc., has developed a method of cooling power transformers by means of an air blast directed against radiators or tubes which is said to be less expensive than similar methods used heretofore, coupled with the advantages of simplicity and compactness.

Large electric fans operated from the station auxiliary circuit are mounted on the tank wall and are covered by suitable hoods for protection from the weather. The tanks are elliptical in horizontal cross-section, and thus serve to deflect the blast of air from the fans over a maximum area of tank and radiator—or tank and tube—surface, without the use of special ducts. The photograph shows a 60-cycle, 3-phase, 34,600-star/11,000-delta, 55 deg. C. rise, transformer, rated at 12,500 kv-a. by natural self-cooling and 18,750 kv-a. when the two fans shown are in operation. The simplicity of the construction as compared to the method employing a multiplicity of small fans, or a large unit blower mounted at the base and forcing the air to the radiators or tubes through ducts, is apparent.

Statement by the General Electric Co., Schenectady, N. Y.

Two record size turbine generators were completed by the General Electric Co. and placed in service: a 208,000-kw., cross-compound unit, and a 160,000-kw., tandem-compound unit, each the largest of its type so far constructed. Of exceptional interest because of its potential influence on the future of central station practice and possible economies, was the growth in the use of turbines operating at steam pressures of 1200 lb., the aggregate capacity of such machines completed or under construction being greater than the combined capacities of the preceding six years.

General Electric Transformers

One of the outstanding accomplishments, in transformer design and manufacture, was the development of the non-resonating type of transformer. In the non-resonating type of transformer, the capacitance charging currents of the various elements of the winding to ground are supplied by means exterior to the winding, i.e., by metallic shields placed outside of the coils. Therefore no charging current, from the coils to ground, passes through the inductance of the coils, so that the voltage drop across any of the coils is a constant, independent of frequency.

The stresses between coils, and from windings to ground, are also greatly reduced. While the non-resonating type of transformer is applicable to any voltage circuit, it is at present only economical for high-voltage transformers, and finds its greatest application on 220-kv. systems where the problem of insulating transformers against transient voltage is the most difficult.

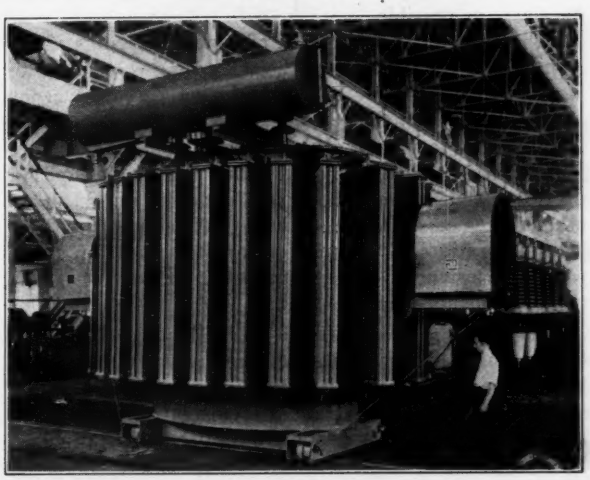
There are already in service a total of twenty-one units, totaling more than 484,000 kv-a., of this type, and 48 units, aggregating 928,000 kv-a., are under construction.

Among these are three 40,000-kv-a., 50-cycle, 220-kv. transformers for the Southern California Edison Co. These are large-capacity single-phase units, designed with partially tapered insulation from the line terminal to neutral. The neutral is designed to be grounded through an impedance which will reduce the current flowing to ground in case of a line fault, but will limit the dynamic voltage rise from neutral to ground to 73 kv.

Another unusual group consists of fourteen 13,000-kv-a., 220-kv. and seven 23,000-kv-a., 220-kv. transformers for the Fifteen Mile Falls Development of the New England Power Co. This will be the first 220-kv. transformer system in the New England States. In order to reduce lightning voltages imposed on the lines, they were designed with minimum height of towers and flat spacing of the wires, each tower being protected with two ground wires.

Four 25,000-kv-a., 50-cycle, 220-kv. to 72-kv. non-resonating type transformers for the Southern California Edison Co. were equipped with load-ratio control in the 72-kv. winding. They were shipped complete in their own tanks, with the load-ratio control mechanism attached.

Three 28,866-kv-a. transformers of this type, for the Pennsylvania Power & Light Co., were provided with extra insulation on account of their being used on a transmission line of more than normal insulation for a 220-kv. circuit. They were tested at 500,000 v.



NEW AMERICAN BROWN BOVERI METHOD OF COOLING POWER TRANSFORMERS

General Electric Load-Ratio Control

Power transformers with voltage taps so arranged as to permit their change under sustained load, a method which has become known as transformer Load-Ratio Control, have found continued application to the extent that of all the power transformers in excess of 500 kv-a. shipped during 1929, 25 per cent by kv-a., were so equipped. Up to the middle of November, approximately 100 units aggregating 1,180,000-kv-a. controlled output had been completed or were under construction during the year.

Among the most outstanding machines built was one three-phase transformer of 45,000-kv-a. output weighing 114 t. complete and ready for service; and six single-phase 20,000-kv-a. transformers, each equipped with two load-ratio controls for the independent regulation of a double secondary winding.

To enlarge the field of application of load-ratio control equipments, a new type was developed capable of handling currents up to 2000 amp. This required the design of a 2000-amp. ratio adjuster and a 2000-amp. contactor.

The inherent advantages in changing the transformation ratio under sustained load were at first taken advantage of only on large transformers, and all necessary component parts like ratio adjusters, contactors, etc., were laid out accordingly for heavy currents and high potentials. As the benefits of load-ratio control, compared with other known methods of alternating-current regulation, became more widely known, however, a demand arose for the application of this method to smaller transformers.

An entirely new line of load-ratio control equipment was designed for currents not in excess of 400 amp. and circuits of 15 kv.

In general, when two generating stations are interconnected for an exchange of power, the voltage at each station is fixed because of the requirements of local distribution. Therefore, if the amount of load to be exchanged is variable, a variable-ratio transformer should be interposed otherwise wattless current will circulate between the two stations. This has been one of the chief uses for load-ratio control transformers. Usually the voltage ratio is adjusted so that the wattless current transmitted over the interconnecting line is as near zero as possible.

The amount and direction of power exchange is determined by the phase angle between the two generating stations and this is controlled by the respective governor settings. Occasionally, due to other interconnections, it is impossible to vary the phase angles of the generators and then the amount of power that can be transmitted over a given interconnection is virtually fixed unless other means of shifting the phase angle can be supplied. The load-ratio control transformer connected for quadrature phase-angle control supplies a convenient means of accomplishing this result.

The Texas Power & Light Co. will utilize for interconnection service two unusual load-ratio control regulating transformers which are interchangeable. The series winding of each transformer has two coils which may be connected in series to give a 10 per cent in-phase buck or boost to the voltage in a 69,000-v., 20,000-kv-a. circuit and when connected in multiple will give a 5 per cent in-phase buck or boost to the voltage in a 69,000-v., 40,000-kv-a. circuit. In addition, each transformer will give a similar quadrature voltage control by means of suitable terminal-board connections. The two transformers may also be connected in series so that one will give in-phase voltage control and the other quadrature voltage control.

Except for the internal connections there is no difference between in-phase and quadrature voltage control. In fact, both may be placed in one unit simultaneously with separate switchboard control for each.

General Electric Oil Air-Pressure Cooled Units

The oil air-pressure system of cooling transformers was during the year applied to transformers aggregating about one million kv-a. in capacity. The largest units so far constructed in the United States are rated single phase, 40,000 kv-a., 220,000 v. but these will be exceeded by four 60,000-kv-a., 132,000-v. units now under construction in England.

Refinements in design have resulted in an appreciable reduction in the amount of power required for the cooling system; while this is of relatively small value in individual units, the widespread application of this method results in a considerable aggregate saving.

General Electric Rectifier Transformers

Increases in the size of power rectifiers involved the construction of larger rectifier transformers. Whereas in 1928, the maximum capacity did not exceed 1500 kw. at 1500 v., the maximum rating during 1929 was increased by the successive construction of units of 3000 kw., 625 v., 3000 kw., 3000 v., and 6500 kw., 650 v., all these transformers being 12-phase units for 12 or 24-anode rectifiers.

In connection with the use of rectifiers for railway power service, transformers were designed for compounding to give normal voltage from no load to 150 per cent load. This required the development of a new method of compounding which consists of a special arrangement of reactors and capacitors in the inter-phase circuit of the rectifier. In addition to giving these desirable voltage characteristics, the new method of compounding causes the rectifier to function at unity power factor at normal load, whereas on ordinary rectifier equipments the power factor ranges from 90 to 95 per cent.

A new standard line of transformers for outdoor and window signs was produced which includes 12 different electrical output ratings ranging from 3500 v. open circuit, 18 m.a. short circuit, to 15,000 v. open circuit and 30 m.a. short circuit.

These transformers are so designed as to have a narrow width in order that they may fit into small narrow signs and between building walls. Four different sizes are included in the new line, and the same mechanical parts are adapted to several different electrical ratings.

November sales of mechanical stokers, as reported to the Department of Commerce by the 10 leading manufacturers in the industry, totaled 107 with 39,469 hp., as compared with 178 of 56,108 hp. in October and 116 of 30,938 hp. in November, 1928.

With an ordinary single eccentric Corliss valve gear, the latest possible cutoff is about 0.4 stroke.

Switching Equipment and Circuit Breakers

NEW EQUIPMENT SHOWS INFLUENCE OF HIGH VOLTAGE TREND. UNDERGROUND, OVERHEAD, INDOOR AND OUTDOOR DEVELOPMENTS NUMEROUS

STATEMENT BY THE CONDIT ELECTRICAL MFG. CO., BOSTON, MASS.

OF MODERATE interrupting capacity, a new manhole oil circuit breaker known as type M-210 has been introduced by the Condit Electrical Mfg. Co. for underground distribution service up to 15,000 v. The

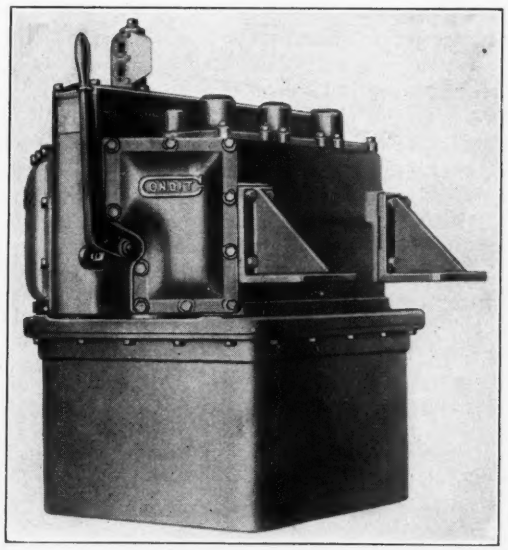


FIG. 1. CONDIT TYPE M-210 OIL CIRCUIT BREAKER FOR UNDERGROUND SERVICE UP TO 15,000 V.

type M-210 is of sturdy, water-tight construction throughout. A massive frame structure, heavily reenforced, supports the operating mechanism, bushings and current carrying parts. In the upper part of the frame, space is provided for two bushing type current transformers per pole in connection with which up to six trip coils can be furnished.

Individual tanks per pole are provided of welded steel plate. They are drawn up tightly against the frame by a strong bolt construction. A light, rapidly accelerating mechanism assures high speed characteristics and easy operation.

Ample insulation is provided. Lead covered cables enter at top through sleeves with wiped joints and terminate in a compound filled pothead inside the circuit breaker from which, in turn, substantial porcelain insulators extend below the oil line. There are no exposed current carrying members above the oil line. The type M-210 is furnished manually operated, three-pole, single throw for 400 amp. at 15,000 v., non-automatic or full automatic, (trip-free) with an estimated interrupting capacity of 60,000 kv-a.

A new outdoor oil circuit breaker has been introduced known as type O-2 for outdoor distribution services at 15,000, 25,000 and 37,000 v.

The tanks are of heavy gage steel, elliptical in shape and heavily welded at the ends and bottom. The tank bottom is hot pressed and reënforced by angles which serve also as grounding lugs and a protection for the drain and sampling valves. A suitable tank lining is provided as a safeguard to prevent the arc from an abnormal circuit interruption from carrying to the tank wall. A gasket is provided around the tank top which effectively prevents oil throwing. The tanks are drawn up against this gasket and the pole tops by short tank bolts.

Condit laminated brushes are furnished protected on closing and opening by exceptionally large arcing contacts whose thermal absorption capacity materially reduces arcing on interruption.

Design of the operating mechanism embodies the highly important features of easy closure and at the

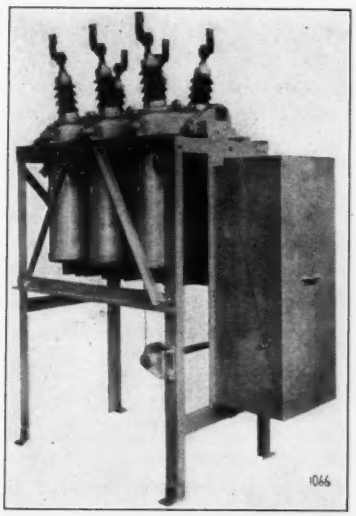


FIG. 2. TYPE O-2 CONDIT OUTDOOR OIL CIRCUIT BREAKER FOR UP TO 37,000 V.

same time affords ample pressure at the contact surfaces. The mechanism as a whole is designed to secure that acceleration of the movable contact member during the opening of the circuit, which has proven to be the most efficient in circuit interruption.

Large one-piece solid porcelain type bushings of high mechanical and electrical strength, extending below the oil line and securely clamped to the pole top with water-tight gaskets, provide more than ample insulation. Provision is made for two bushing type current transformers per pole. Series type current transformers mounted within the breaker tank may also be supplied if required. The pole units are mounted on a supporting framework of angle iron, rigidly and substantially constructed.

Type O-2 oil circuit breakers are furnished for 400,

600 and 800 amp. The estimated interrupting capacity at the different voltages is given in the following table:

Volts	Kv-a.
15,000	200,000
25,000	150,000
37,000	100,000

Furnished manually or electrically operated (a.c. or d.c.). Electrically operated breakers may be arranged for automatic reclosing service of one or more closing cycles with constant power or varying time delay, affording minimum interruption to service.

Another notable development for high current carry-capacity combined with high interrupting ability was the type F-120-15D, 4000-amp. truck type oil circuit breaker for 15,000-v. service, a heavy duty addition to the F-120 line of power breakers.

Contact system, studs, bushings and mechanism are firmly supported by a massive, dome-shaped, cast-steel

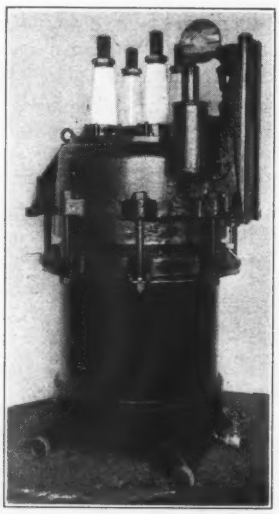


FIG. 3. TYPE F-120 CONDIT TRUCK TYPE OIL CIRCUIT BREAKER FOR 15,000 V.

top which is in turn supported by a channel and angle iron structure on wheels. The tank is of boiler plate steel, cylindrical in shape with rounded bottom supported from the frame by a number of short heavy bolts. A deep reënforcing flange on the pole top extends down over the tank for several inches.

To afford the necessary current capacity without undue heating, four studs per pole unit are used, each with a capacity of 2000 amp. Inside the breaker, these studs are clamped in a pair of heavy contact blocks, two studs to each block. From each block extend three inverted laminated brushes, all of which make firm contact with a single bridging member of heavy copper.

Arcing contacts are designed on the principle of energy absorption. Eight heavy cylindrical blocks of copper are provided to afford such thermal absorption capacity as materially to reduce arcing on interruption. Four series breaks are used to reduce further the duration of arcing. The design of the arcing contact circuit makes use of the electro-magnetic forces developed on high current rushes to insure that arcing contacts remain closed with strong pressure until the brushes have safely parted. The type F-120-15D has an estimated interrupting capacity of 1,000,000 kv-a. at 15,000 v.

Statement by the Delta-Star Electric Co., Chicago, Ill.

The Delta-Star Electric Co. has developed a new line of drop forged pipe fittings, known as "Unielamp" for use in building pipe structures.

There are but five parts from which any desired combination of elbows, tees, crosses, side outlets, flanges or braces can be assembled.

These new fittings are made for ¾-, 1-, 1¼-, 1½- and 2-in. pipes will permit a great reduction in stocks required with the ordinary type of fitting.

Statement by the General Electric Co., Schenectady, N. Y.

Growth in size of transmission and distribution systems and the corresponding increase in the required size of outdoor switching equipment has served to concentrate developmental work on both the mechanical structure and the electrical apparatus used in these stations with the idea of effecting as much reduction in their cost as could be secured without jeopardizing the vital factor of reliable performance. Many of the improvements made by the General Electric Co. are of detailed character, but the economic results obtained have fully justified the effort expended on them.

A new type of group-operated horizontal-break disconnecting switch was produced in ratings of 88 to 154 kv. inclusive, which is particularly applicable to isolating service.

Another new group-operated switch, which is made in one rating of 15,000 v., 200 amp. is a moderate-duty tilting-insulator horn-gap type of vertical-break design and was designed primarily for service on rural lines and low-capacity distribution systems.

The operation of this switch can be performed either manually or by means of a motor mechanism consisting of a motor-driven gear-reduction, opening and closing contactor, mechanical brake, and the necessary auxiliary switches, all enclosed in a fabricated-steel weather-proof housing. The motors are designed for operation at 110 and 220 volts, alternating current, and 115 and 230 volts direct current. Through a flexible coupling and gear reduction, they are connected to an operating crank which rotates in the same direction for both the opening and the closing of the switch.

An over-insulated horn-gap type switch of unusually heavy construction was designed for use particularly on 66-kv. systems.

A line of current-limiting resistors in ratings up to 73,000 v. permits the application of a fuse in combination with the resistor on the primary of the potential transformers on systems where the possible short-circuit can exceed the fuse-interrupting capacity. The function of the resistor is to limit the amount of current which can flow into a fault, so that it will be kept well within the interrupting capacity of the fuse.

General Electric Metal Panels

Although the employment of steel for switchboard panels is not new, a number of improvements in design were made. An exceedingly compact arrangement was secured by placing the panels back to back with approximately 20 in. between them. Access to the interior of

the structure is secured by hinging the rear panels, the surfaces of which are used for mounting maintenance equipment.

Steel bench-board construction was utilized for a particular type of control board in the steel industry. It gives the operator clear vision over the top of the bench and the necessary instruments can be read while manipulating the control levers mounted on the bench. Two installations were made, one for the control of a 6600-v. mill motor and a 600-v. motor-generator, and another for controlling a 2500-kw., 250-v. motor-generator and 11 d.c. motors.

A number of metal-panel units for synchronous-motor control were installed side by side, forming a totally enclosed structure accessible at the rear by means of swinging doors. This type of construction is also applicable to feeder service where moderate capacities and voltages are involved.

General Electric Metal Clad Gear

During the year, a large increase in the use of indoor metal-clad gear took place. As before, the air-insulated type has been most popular but a number of oil-filled designs were built. These oil-filled equipments were used in locations such as steel mills, when dust-tight requirements had to be met.

Of particular interest is a panel section for relaying. The panel carries five three-phase relays with current indicators as part of the metal-clad structure.

General Electric Oil Circuit Breakers

Studies of system stability have indicated the need for switching apparatus which, in the minimum of time, would remove line troubles leading to short circuits. Extensive investigation with the explosion-chamber type of breaker, through arrangements with the Philadelphia Electric Co., included short-circuit tests on the 220-kv. system of that company.

These tests demonstrated that the oil circuit breaker under test operated in a considerably shorter time than the conventional oil circuit breaker and indicated that still further reductions in operating time were possible of attainment.

A new indoor breaker was designed for severe service with interrupting capacities from 350,000 to 2,500,000 kv-a. in various tank sizes from 16- to 36-in. diameter. It uses a separate round tank for each phase and is rated for 15,000, 25,000, or 37,000 v., with normal current ratings up to 4000 amp. This type was developed to supersede two earlier types of breakers and embodies certain improvements such as a top frame of plate-steel design, formed on the dome principle, and strongly welded throughout; a more substantial mechanism and an improved contact construction.

The tanks are of plate steel having dish-shaped bottoms. The tanks having 16- and 20-in. diameters are pressed in one piece; the larger sizes are rolled and the seams reënforced with a welded overlap plate. The tanks are secured to the top frames by short bolts with claws which catch a steel band welded to the tank.

The usual self-alining finger and wedge contacts are used for breakers of lower interrupting capacities, while the explosion chamber is used for breaking the arc for the wedge and finger primary contacts on the breakers of higher interrupting capacities.

With the foregoing improvements, together with the retained advantages of the older types, these breakers are suitable for indoor service of maximum severity. They are also available for both indoor and outdoor metal-clad switchgear which is a new field for such breakers.

Another new indoor oil circuit breaker serves to disconnect the shunt circuit of an induction regulator when it is inconvenient or impossible to interrupt the exciting current by the feeder oil circuit breaker. It is single-pole, single-throw, non-automatic, and has a rating of 4500 v., 60 amp.; however, it is insulated to withstand repeated high-voltage surges up to 24,000 v.

It is operated by a switch hook and a safety latch locks the contacts in the closed position. It has a strong frame of formed-sheet steel punchings. The bushings are of one-piece porcelain extending below the oil level. Oil-immersed copper contacts open and close with a wiping motion which tends to keep them clean and no adjustment is required.

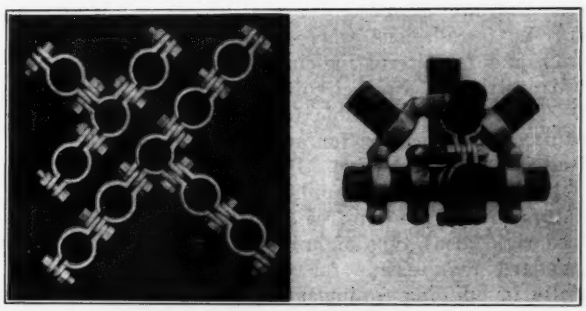


FIG. 4. DROP FORGED FITTINGS DEVELOPED BY THE DELTA STAR ELEC. CO.

The explosion chamber has long been recognized as the most efficient means for decreasing the volume of gas generated and the pressure produced in interrupting short-circuit currents at any voltage. The demonstrable decrease in short-circuit time made possible by the use of these explosion chambers has concentrated further attention on their design. This led to the development of a non-metallic explosion chamber for use with oil circuit breakers rated from 110 to 220 kv. The explosion chamber itself is made of Herkolite, molded at high pressure and cured at a high temperature.

Oil circuit breakers rated 88,000 v. and above can now be equipped with high-voltage capacitance-transformer bushings suitable for operating potential devices to obtain transformation from high voltage to low voltage for the operation of synchroscopes and relays.

The potential device utilizes the charging current of the high-voltage bushing as the source of energy and furnishes a secondary voltage substantially in phase with, and in proportion to, a line-to-ground voltage.

Each potential device is contained in a waterproof house which is mounted on the side of the breaker unit adjacent to the high-voltage bushing. Connection is made from the bushing top to the potential device by means of a lead-covered cable with overlapping and interlocking steel armor.

General Electric Air Circuit Breakers

A small mechanically-strong air circuit breaker was designed for light-duty service and is especially applicable for building equipment. It is made single, double,

or triple-pole, in capacities from 3 to 300 amp., 650 v., d.c. or a.c., with automatic overcurrent release and is trip-free.

A line of substantially-built, trip-free, air circuit breakers was developed for moderate-duty service. They are conservatively rated and have a high interrupting capacity. The width of the breaker is kept at a minimum by locating the over-current tripping mechanism below the breaker poles. This type of breaker is used extensively for general industrial and building equipment service and also on lighting and power switchboards. It is built in capacities from 15 to 1200 amp., 650 v., d.c. or a.c., single, double and triple-pole, complete with accessories.

Another new line comprises automatic overcurrent air circuit breakers of the following capacities: single-pole, 1600 to 10,000 amp., 650 v., d.c.; 1600 to 4000 amp., 650 v., a.c.; double-pole 1600 to 6000 amp., 650 v., d.c.; 1600 to 4000 amp., 650 v., d.c. or a.c. They are substantially constructed, have high interrupting capacities and are designed for the protection of direct-current installations where the current is over 1200 amp. and for alternating-current service that does not warrant the use of oil circuit breakers.

They are also suitable for power feeders, building equipment service, or for any other circuit where the load is highly inductive. Being trip-free, they fill an important need in the application of apparatus of this nature in that the trip-free (so-called non-closable overload rigid arm) type of breaker is rapidly becoming a standard requirement for certain applications, especially in building equipment.

Improvements were made in the design of a single-pole solenoid-operated 650-v. direct-current high-speed switchboard type of air circuit breaker, which is used extensively in automatic-station and steel-mill service. An inverse-time-limit feature was added, and the line was extended to include 6000 and 10,000-amp. capacities.

General Electric Network Protectors

Trip-free motor-operated submersible network protectors were provided with improved features.

These devices are for use in low-voltage alternating-current secondary network systems, their function being to disconnect transformers on a primary feeder from the network in case of transformer or primary-feeder short circuits. The motor-operated centrifugal mechanism closes the magnetic blowout circuit breaker contacts when conditions are normal as determined by the operation of a phasing relay and a polyphase reverse relay. These relays cause the opening of the protector contacts to prevent power flow from the network toward the feeder.

The improved main current carrying contacts are of single-break line type, silver to silver, and are self-alining. The breaker unit is mounted on insulating bars, instead of the conventional insulating base, providing free circulation of air around the conductors. The breaker unit may be rolled out on rails which are provided in the submersible enclosing case without disturbing or deënergizing the cable connections.

Statement by the Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

During the past 18 months, the Westinghouse Elec. & Mfg. Co. has supplied numerous factory fabricated switchgear assemblies using welded structural steel. Ordinarily these assemblies, or bus structures are so constructed that each section is a self-supporting unit, i.e., that the sections are shipped separately. The erection of such a structure involves little labor since it is necessary merely to bolt the adjacent sections together, place the bus bars and make connections to outgoing power and control leads. The circuit breakers, disconnecting switches, instrument transformers and copper connections for each section are shipped in place.

With the object of further reducing field erection work this company furnished a welded structural steel circuit breaker structure completely equipped with the circuit breaker disconnecting switches, instrument transformers and copper connections to be built and shipped as one multi-section unit. There is now on order for the Pennsylvania State College a nine-circuit structure using one type B-16 breaker per circuit. This structure is approximately 22 ft. long, 10 ft. high and 42 in. wide and will weigh 9 t. Shipping channels are fastened to the top portion of the structure and these will enable the purchaser to handle the structure by crane without danger of racking the structure. Customary skids on the bottom will provide for moving the structure from a flat car to a position where it can be picked up by the crane. With such a structure, the field erection work is reduced to a minimum. All bus bars and connections are in place so that the field work resolves itself into moving the structure to its final location and connecting the power and control leads. Power companies are beginning to realize more and more that the conditions encountered in field fabrication and erection cannot compete with factory facilities and methods. For this reason, there should be an increasing demand for this type of circuit breaker structure for small and medium sized substations and power stations.

Sublimation is the name given to a process of distillation where a solid is converted directly into a vapor without going through the usual intermediate stage. Gum camphor is perhaps the most common substance which does this and crystals on cold parts of the bottle can be converted into vapor by warming or can be converted back to crystals by cooling. Iodine crystals in a stoppered bottle will do the same thing. The new refrigerant solid CO_2 does the same thing and it is this property of evaporating without wetting to which this snow owes its popularity and practicability for certain services.

At very low pressures, the vapor of a given substance must be cooled to an extremely low temperature to produce condensation. If this temperature is below the freezing point of the substance, the vapor will be condensed in solid form without passing through the liquid stage. Thus, under certain conditions of low moisture and low temperature in winter time where the temperature of the air is below freezing, the moisture is condensed in the form of snow flakes or frost crystals, so that under certain conditions physical changes in water take place by sublimation rather than by the double process melting and boiling.

When measuring gases or superheated vapors, finned tubes should be used, as they compensate more or less for the low rate of heat transfer from the gas to the bulb.

MOTOR STARTERS

BOTH ALTERNATING AND DIRECT CURRENT STARTERS FROM FRACTIONAL HORSEPOWER TO LARGE SIZES RECEIVE MUCH ATTENTION

STATEMENT BY ALLEN-BRADLEY CO., MILWAUKEE, WISC.

BULLETIN 825, Allen-Bradley Co., fractional horsepower overload breakers are designed for protection of small motors on pumps, fans, machine tools and compressors, when starting and running overload protection is desired. These overload breakers provide accurate and reliable protection that cannot be obtained with fuses.

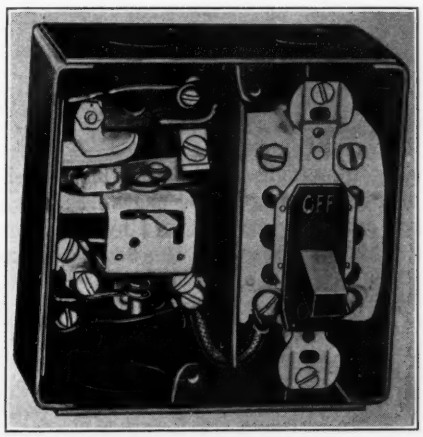


FIG. 1. BULLETIN 825 ALLEN-BRADLEY FRACTIONAL HORSEPOWER OVERLOAD BREAKER

This breaker is made in several forms to meet the requirements of all applications, such as 2-wire control for float switches. This overload breaker is designed for use with either alternating or direct current motors of a maximum rating of 1 hp., 125 v. and 1½ hp., 250 v. When used in heater circuits or similar applications, the breaker has a maximum current rating of 15 amp. at 125-250 v. for alternating or direct current. Bulletin 825 overload breakers are furnished as a single unit or equipped with fuse clips or snap switch, or both.

The soldered ratchet principle is used, which releases the breaker at the current value irrespective of the number of times it operates. The overload setting cannot be changed without changing the heater element, which eliminates tampering by operators. A magnetic blowout coil is provided to disrupt heavy arcs.

Bulletin 711-712 Switches are the well-known standard Allen-Bradley across-the-line switches with the additional features of outside operated disconnect switches and separate test jacks. The unit of these three elements in one cabinet simplifies the starting installation and subsequent rearrangements, eliminating much wiring and conduit work. The disconnect switch gives positive and quick action. A separate set of three test jacks are mounted between the disconnect switch and the automatic starting switch. They extend into an insulating plate in the cabinet cover and are protected by a hinged door. These clips do no switching and therefore are always clean and smooth, assuring excellent contact with the test plug. Machine operation is not interfered with.

Allen-Bradley Bulletin 711-712 Switches provide overload, dead-phase and no-voltage protection. The Type A switch will disrupt a locked motor current. The

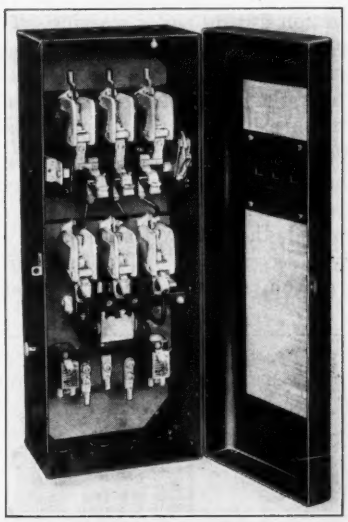


FIG. 2. ALLEN-BRADLEY BULLETIN 711-712 ACROSS-THE-LINE DISCONNECT SWITCH AND TEST JACKS

Type B switch is a motor service switch that disrupts 150 per cent motor full load current. Rated up to 10 hp., 110 v., 30 hp., 220 v., and 60 hp., 440-550 v. Made in three forms: Form 1, with push buttons in cover; Form 2, for pilot control and Form 3, with 3-way lever switch.

The Bulletin 707 Splash-Proof Starting Switch has a cast-iron splash-proof cabinet which makes it ideal for use in laundries, creameries and packing plants, where considerable moisture is present or where wash-down of machinery is necessary; it also is ideal for dusty installations.

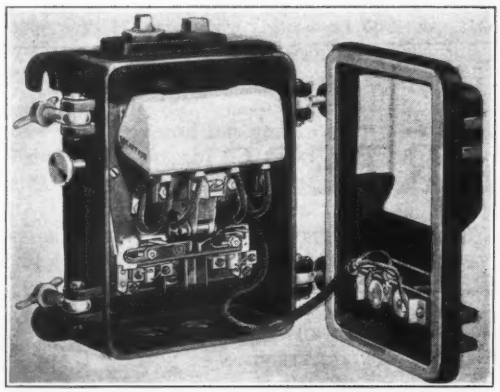


FIG. 3. SPLASH-PROOF ACROSS-THE-LINE SWITCH BULLETIN 709WT OF ALLEN-BRADLEY CO.

This starter provides up-to-date protection to man, motor and machine. The magnetic switch eliminates hazards of hand-operated starting switch. No-voltage protection prevents accidental closing of switch. Thermal relays provide overload and phase failure protection. The starter is furnished for single-phase motors up to 3 hp., 110 v. and 5 hp., 220 v.; also for polyphase motors up to 5 hp., 220 v. and 7½ hp., 440-550 v. It is furnished in three forms providing economical installation for every application.

The feature of the Bulletin 648 starter is the combination of an auto-transformer with a resistance starter of the graphite compression type to eliminate voltage fluctuation during motor starting. The graphite compression starting resistors are in series with the auto-transformer when the starter is first connected to the line. The resistors eliminate the objectionable exciting current inrush of the starting compensator and prevent voltage fluctuation during starting.

The motor is accelerated by gradually reducing the starting resistance until the motor is connected to full line voltage and the resisto-transformer combination automatically disconnected. Stepless, velvet-smooth acceleration of squirrel-cage motors is provided under any load conditions. Motor is accelerated and connected to the line at full speed without opening line circuit. The second inrush of current is thus prevented. Complete overload, dead-phase and no-voltage protection.

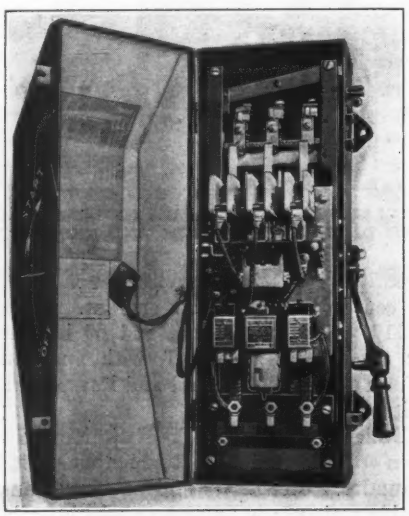


FIG. 4. ALLEN-BRADLEY SQUIRREL-CAGE MOTOR STARTER BULLETIN 648

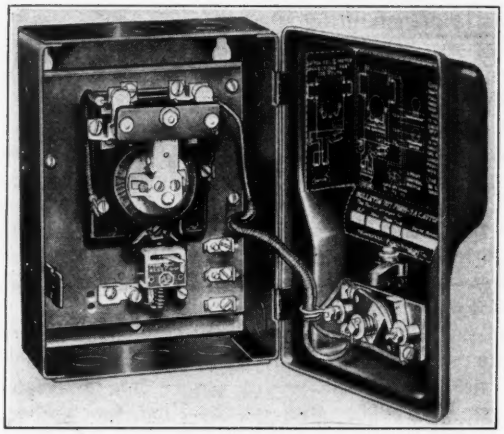


FIG. 5. SMALL SINGLE PHASE MOTOR STARTER, ALLEN-BRADLEY BULLETIN 707

Bulletin 648 Resisto-Transformer Starter is used for squirrel-cage motors rated up to 75 hp., 220 v. and 125 hp., 440-550 v. at 50 and 60 cycles. For 25 and 30 cycles, the maximum rating on 220 v. is 30 hp., and on 440-550 v. is 50 hp.

Bulletin 707 Single Phase Starting Switch is for motors operating refrigerating machines, compressors, pumps and other devices governed by 2-wire or 3-wire controls. This starting switch is a double-pole magnetic switch with a double winding which permits the switch to be used interchangeably up to 1½ hp., 110 or 220 v. by simply changing terminal connections. Maximum rating on 220 v. is 3 hp. A Resisto-therm overload relay provides accurate and reliable overload protection.

Statement by the Condit Electrical Mfg. Co., Boston, Mass.

During the past year, the Condit Electrical Mfg. Corp. has brought out many new developments, some of which are of such a character as to be considered a distinct advance to the industry.

Of particular interest is the new type A-30 cross-the-line air motor starter for use with squirrel cage induction motors up to 20 hp., 550 and 440 v.; 15 hp., 220 v. and 7½ hp., 110 v.

This starter has caused widespread interest due to a design involving a new principle of circuit interruption; namely, arc-prevention. Exhaustive tests show there is only a spark when interrupting currents six to seven times its normal rating and relatively no contact burning, no gas, indicating a minimum of maintenance.

The Condit type A-30 is unusually simple and compact, no magnetic blowouts or arc chutes are used. It is enclosed in a substantial pressed steel case arranged with conduit knockouts. Furnished for push button control with control on cover or in separate bush button, equipped with automatic or hand reset thermal relays for time-lag overload protection and arranged for undervoltage protection; approved by Underwriters' laboratories and Associated Factory Mutual Fire Insurance Companies.

STATEMENT BY CUTLER-HAMMER, INC., MILWAUKEE, WISC.

A new counter e.m.f. type automatic starter for general applications of d.c. motors up to 2 hp., 115 or 230 v., is announced by Cutler-Hammer, Inc., Milwaukee, Wisc. Important features incorporated in this new design are: reduced voltage starting, low voltage protection, the thermal overload protection and low cost.

Another development, a new, automatic, across-the-line starter, for general applications of d.c. motors up to 2 hp., 115 or 230 v., is also announced. Important features incorporated in this new design are: double line break, low voltage protection, "renewable" silver

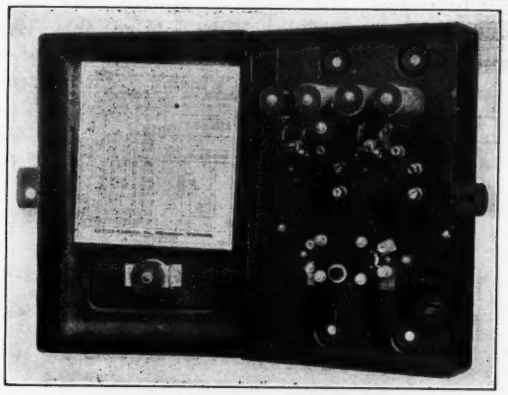


FIG. 6. NEW CUTLER-HAMMER COUNTER E.M.F. AUTOMATIC D. C. MOTOR STARTER

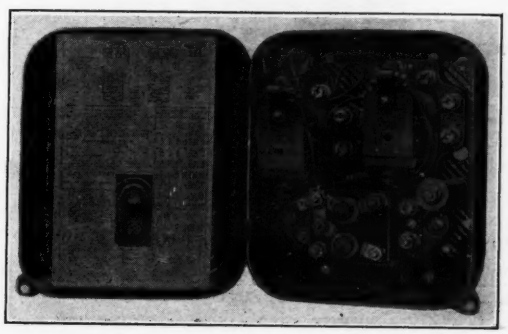


FIG. 7. CUTLER-HAMMER ACROSS-THE-LINE D. C. MOTOR STARTER

contacts, completely enclosed case, the thermal overload protection and low cost.

Thermal overload relays used on both starters are the same as those used in this company's a.c. across-the-line starters and are the fusible alloy type which can be adapted to any size motor by simply changing the heater coils. When tripped by an overload, the relays are reset by pushing a button in the cover.

Each starter is furnished with a pushbutton master switch providing three-wire control. This master switch can be furnished mounted in the cover of the starter, or it can be arranged for mounting separately.

STATEMENT BY THE GENERAL ELECTRIC CO., SCHENECTADY, N. Y.

Some of the developments of the General Electric Co. follows:

A new line of printing-press controllers for direct-current motors which utilizes definite-time acceleration, which is essential in order to give the proper delay in accelerating to printing speed. The present speed is obtained by an external handle which actuates the rheostat; thereby regulating the amount of resistance in the field circuit. As compared with the previous controllers for this service, the new line reduces the number of contactors required and provides superior definite-time control.

A small and compact three-point definite-time starter was developed for direct-current motors rated ¾ to 3 hp., 115 and 230 v. Although there is a reduction in the size over previous designs, the number of accelerating points is actually increased. Definite time acceleration is adjustable over a range from two to eight seconds.

Resistors are used in such large numbers that, broadly considered, any improvement in them is of great economic value to industry in general.

An edgewise-wound resistor embodying three new features was developed. It utilizes insulators of fused alumina compound, a material many times stronger than porcelain and maintaining a higher dielectric strength when heated to high temperatures. The terminals are brazed to the resistor ribbon, thus preventing all loose joints and terminal burn-outs, and elongated windings permit more length of ribbon per turn hence more watts per cubic inch, resulting in more compact units for the dissipation of a given amount of energy.

The resistor is of light weight and utilizes stainless-steel ribbon which insures a low temperature coefficient of resistance. It has double insulation to ground.

STATEMENT BY THE ROWAN CONTROLLER CO., BALTIMORE, MD.

Main developments in the line of The Rowan Controller Co. for 1929 have been the rounding out of its vapor proof equipment by the addition of a new Type 6150 Oil Immersed Push Button and its Type 6200 Oil Immersed Safety Switch.

These additions, together with the Type 7375-B Starting Switch, make the first complete oil immersed, vapor-proof equipment for starting squirrel cage motors across-the-line.

The two essential features of this new equipment are the fact that it is oil immersed and the outside covers are largely of cast iron so as to adapt them to the severest atmospheric conditions.

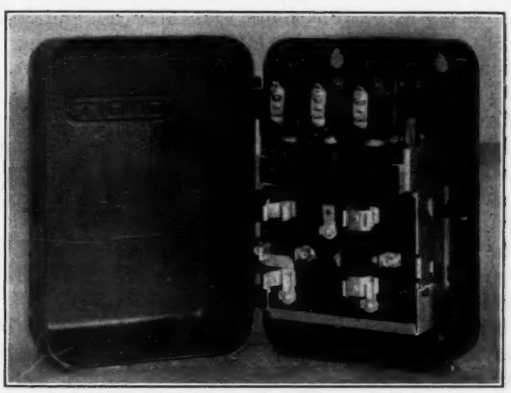


FIG. 8. CONDIT TYPE A-30 ACROSS-THE-LINE AIR STARTER FOR MOTORS UP TO 25 HP.

Figure 9 clearly shows the rugged features of this equipment, which is now being extensively used in the chemical, cement, steel mill and allied industries.

STATEMENT BY THE TRUMBULL ELEC. MFG. CO., PLAINVILLE, CONN.

Chief developments of the Trumbull Elec. Mfg. Co. are the type TT and TM motor starting switches. The first provides overload protection for fractional horsepower motors while the second, built for larger sizes, protects the motor the same as a magnetic switch except that it is manually operated and has no under voltage release.

The new type M-7½ magnetic switch and disconnect

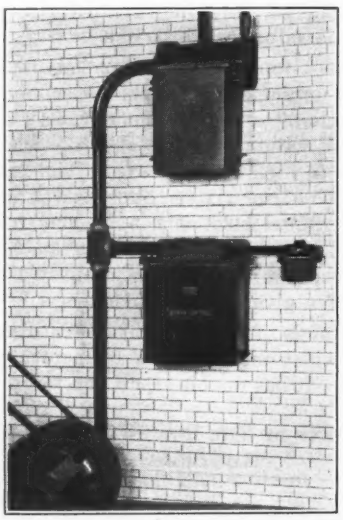


FIG. 9. ROWAN VAPOR-PROOF OIL IMMERSED PUSH BUTTON AND SAFETY SWITCH

in one cabinet is quite revolutionary and makes an economical set-up.

STATEMENT BY THE WESTINGHOUSE ELECTRIC & MFG. CO., PITTSBURGH, PA.

During the past year, Westinghouse Elec. & Mfg. Co. has released a number of important control items. A few of these are discussed below:

The "Deion" arc box is a part of several of the new alternating current contactors. This unique device has, in some cases, doubled the horsepower rating of the contactor when used as an across-the-line starter.

A temperature overload relay with automatic or hand-reset and quick break contact mechanism is now available. The relay makes use of bi-metal and simple interchangeable heater units. It is a part of the new "line starters" and may be supplied as a complete independent unit.

Another temperature responding device used for over-temperature protection of bearings, grids, transformers, cables, etc., is now in production. A bulb on the end of a long tube is located at a point where heat is apt to develop. A rise in temperature causes pressure to be transmitted along the tube to a metallic bellows which expands and operates a positive acting spring toggle switch. Response of the switch may be accompanied by the movement of a semaphore which indicates operation and latches the contacts in place. The relay may be set so that it will return automatically when the temperature falls. Connections may be made for either contact make or break. The bellows and bulb system is so designed that in case of a leak the relay will indicate trouble.

While manual controllers, as used for cranes and similar applications, are not ordinarily of outstanding interest, the new type A drum controllers are unique. They have been called the "meccano" type controllers. For a given ampere rating, the controllers are identical except for arrangement and number of segments. As externally viewed, the height of the complete line of 100 and 150-amp. controllers is the only variable. Extra long life of segments is obtained through a totally different method of attachment which permits reversal. Fingers are self-alining and require a minimum of care and replacement. Operating heads include horizontal handle, vertical handle, right angle gear drive, rope

FIG. 10. TRUMBULL TYPE TT STARTING SWITCH FOR FRACTIONAL HORSEPOWER MOTORS

wheel spring return and horizontal handle spring return. Ball and roller bearings provide easy operation and permit mounting of controllers in any position. The line comprises direct current crane controllers, direct current general purpose reversing controllers, alternating current wound rotor motor, non-reversing and reversing controllers and semi-magnetic controllers for wound rotor motors.

The "Timestarter" is the newest direct current general purpose motor starter. Its time delay characteristic is obtained through the use of an ingenious rotary pendulum device which may be set to provide time limit between 2 and 6 sec. The timing mechanism as a separate unit, operates without fault when mounted in any position. The 10-hp., 230-550-v. starter has three points of acceleration, temperature overload protection with automatic or hand reset, and may be provided with dynamic braking and full field starting.

The carbon pile regulator for direct current machines has been available for a number of years; however, this type as applied to the regulation of alternating current

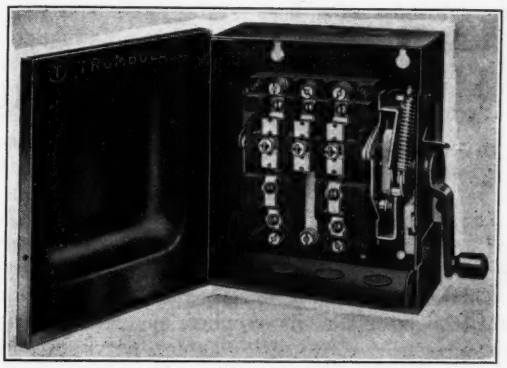


FIG. 11. TYPE TM TRUMBULL MOTOR STARTING SWITCH FOR LARGER MOTORS

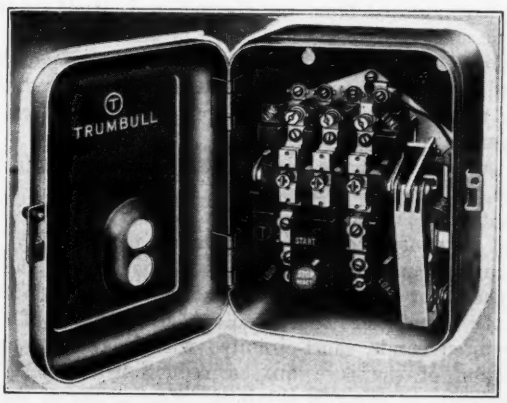


FIG. 12. TYPE M-7½ TRUMBULL MAGNETIC MOTOR STARTING SWITCH

machines has only recently been developed. It is now available in two sizes. The carbon pile is connected in the exciter field circuit and the regulator magnet coil is connected to the alternating current bus. A simple lever system transfers the variations in magnetic pull to the carbon pile which is compressed in varying amounts. Variations in alternating current voltage are transferred to the carbon pile as changes in pressure with a consequent variation in exciter voltage, thereby maintaining the normal alternating current voltage. Anti-hunting or reaction is obtained through an air dashpot connected through two springs to the lever system. The anti-hunting device acts to recalibrate the regulator upon a change in voltage and the air dashpot restores the calibration to normal. This method for the prevention of hunting is very simple and exceedingly effective. The regulator is rugged in design, simple in construction and operation, is readily understood and comparable in performance to the well known vibrating regulator. Practically no maintenance is required.

A real economy in installed cost of a.c. distribution switching equipment in addition to a finished product of superior appearance has been secured in the recently developed line of steel-clad cubicles. The noteworthy points of a recent installation for the Pacific Gas & Electric Co. are:

Conservation of space—the breaker and instrument transformer compartment, double-bus compartments, disconnecting and selector disconnecting switches, breaker control compartment, and meter and relay panels are parts of one integral structure.

Complete isolation and segregation of primary circuit and control circuit compartments.

Welded steel construction throughout.

Ease of inspection of control wiring and devices—meter and relay panel for each unit is a swinging member forming the front door for the control compartment.

Pleasing appearance of the complete structure—the use of best grade material for meter panels and the benefits derived from factory workmanship results in a completed job which could not be duplicated in an installation where the assembly is done in the field.

Lower installation costs to the customer, each unit shipped with breaker structure, disconnecting switches, instrument transformers, metering and control panels built into the equipment. The result is that the clamping in place of straight runs of bus copper in addition to connection to primary conduit and a control source was all that was required by the customer for a complete installation. The factory test is made with final connections, thus eliminating expensive field tests.

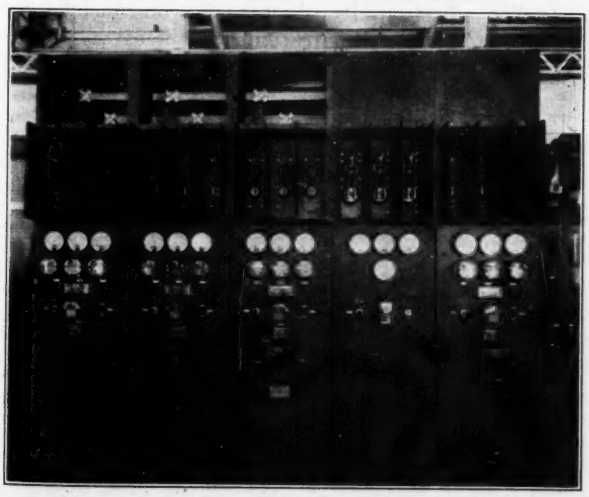


FIG. 13. SWINGING METER AND CONTROL PANELS IN A RIGID STRUCTURE AS DEVELOPED BY WESTINGHOUSE

FRICTION PLAYS an important part in all phases of engineering as it is present in all cases of motion. In general, four types of friction must be considered, sliding friction, fluid friction, rolling friction and drag due to unevenness.

Sliding friction takes place between the crosshead and guides of an engine, the shaft in the bearing and similar cases. Fluid friction takes place when air or water flows through a pipe, when a boat is forced through water or when a projectile or aeroplane flies through the air.

Rolling friction is due to the yield give of a road bed or rail over which a wheel is drawn. The effect is much the same as though the vehicle were going continually up hill. Unevenness causes a different type of drag, an uphill and a downhill effect which has little effect on the average pull at low velocities but which, at high velocities, is considerably manifesting itself in vibration and swaying, a pronounced cause of frictional drag at high velocities.

Electrical Instruments for High and Low Voltage

Voltage Transformers, Potential Transformers and Oscillographs Among Instruments That Have Been Improved

Statement by the General Electric Co., Schenectady, N. Y.

FOR GENERAL PURPOSE use, a new oscillograph has been made available. This is a six-element instrument of the permanent magnet galvanometer type with all essential parts arranged compactly for simplicity of operation. The galvanometers are of unique design. Single and polyphase wattmeter elements are interchangeable in the case with the usual voltage and current galvanometers. The light source is an incandescent lamp. Film holders of the magazine type for

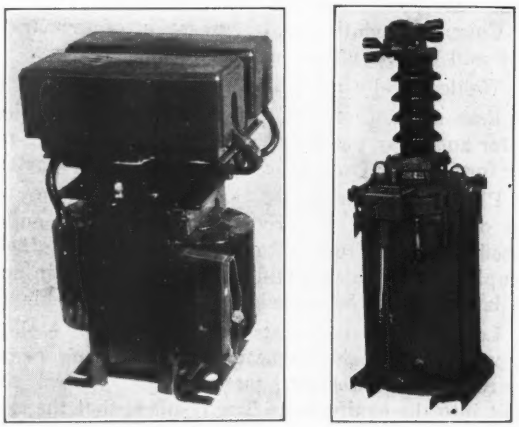


FIG. 1. A. WESTINGHOUSE 2300-V. POTENTIAL TRANSFORMER WITH FUSES. B. 25,000-V. OUTSIDE OIL INSULATED CURRENT TRANSFORMER

three or five exposures, and of the continuous-drive type for long films are available. The operation of the oscillograph is from a single power source, either a 6-v. storage battery or an a.c. supply.

Four single-phase 60-cycle metering equipments for 220,000-v. circuits were constructed with shielded potential elements and coördinated insulation throughout. These outfits will withstand higher impulse voltage than the line insulation.

The potential element is built on a two-legged core and the coils are stacked on one leg surrounded by a shield, thereby rendering the transformer non-resonating under transient conditions. The current element is also built on a two-legged core with one low-voltage coil on each upright leg, and the high-voltage winding over one of the low-voltage coils. Four high-voltage coils may be connected in series, series multiple at the top of the high-voltage bushing for ratings ranging from 150 to 600 amp. The bushing designed for this equipment is 18 ft. long and weighs 4000 lb., and the complete outfit requires 46,500 gal. of oil; the total weight with oil being 76,500 lb. These are the highest voltage metering equipments so far constructed.

In the measurement of temperature by means of thermo-couples, it is necessary to have the equivalent of a fixed temperature of reference. In a new instrument, this equivalent is supplied by the use of a temperature-sensitive magnetic counter-torque in addition to the ordinary spring control. This instrument will be particularly useful in numerous applications of temperature measurement where the measuring apparatus, as distinguished from the thermocouple itself, is likely to be subjected to a wide range of temperatures. Calmaloy, the magnetically temperature-sensitive material used for temperature correction in watthour meters, is the material used and is the key to this form of temperature measurement.

A new magnetic circuit for current transformers was perfected, in which a few secondary turns appropriately placed include only a portion of the core so that the effect of the changes of permeability with change of current in closely related portions of the core is such that a considerable reduction of the ratio errors of the transformer is secured. Also, by means of short-circuited bands, short-circuited with relation to only a portion of the core flux, a reduction in the phase-displacement error is obtained. The action of both of these means of correction is such that at low currents, where the need for correction is greatest, the largest effect is produced.

A new form of telemeter receiver is intended for use with other telemetering apparatus of the class in which the quantity to be indicated is represented in the communication circuit by a series of impulses of a frequency proportional to that quantity. The new receiver makes use of the current that appears in a secondary circuit as the consequence of the magnetic discharge of an iron core. The core and circuits associated with it are so designed and proportioned that the quantity of electricity discharged, consequently the instrument indications, are independent of the voltage of the exciting circuit. The receiver may be made either as an indicating or as a recording instrument and is well suited to the measurement of power and indeed of any quantity that can be represented as a series of impulses of a frequency of the order of two or three per second for the full scale of the instrument.

A complete new line of rectangular instruments, uniform in size and appearance, was designed for both alternating-current and direct-current service. The line includes ammeters, voltmeters, wattmeters, reactive-volt-ampere meters, power-factor meters, and frequency meters. The instruments are uniformly 6 in. high by 5½ in. wide by 3½ in. deep, thereby making it possible to mount four instruments across the face of a 24-in. switchboard panel.

A special non-glare glass is used which, in combination with an anti-parallax scale and pointer, facilitates reading regardless of the angle from which the instruments are viewed.

Internal resistances are used with all instruments with potential circuits except for the higher-voltage polyphase wattmeters. The moving elements are provided with ground-steel pivots mounted in sapphire bearings. "Dead-beat" indications are obtained by means of magnetic damping.

Miniature instruments of improved construction were designed for 2¼- and 3-in. diameter cases for use on both alternating-current and direct-current lines.

They are provided with molded compound case and bases, the case being threaded so as to screw on the base. The line includes instruments for use on low-voltage alternating-current circuits. These instruments are of high resistance (1000 to 2000 ohms per volt). This high resistance in an instrument for low-voltage alternating current is made possible by the use of rectifiers which are provided inside the case of a direct-current instrument.

Statement by the Westinghouse Electric & Mfg. Co., Pittsburgh, Pa.

Trend of development in instrument transformers during the past year has been in the direction of better appearance, greater mechanical strength, standard voltage ratings, and improved accuracy. Improvements in existing designs and extensions of existing lines by the Westinghouse Elec. & Mfg. Co. have been the rule rather than anything radically new.

Westinghouse Voltage Transformers

The dry type potential transformers for the lower voltages have been redesigned to have better ratio and phase angle curves and better mechanical arrangement. The improvement in performance has resulted from a better balance in the design and at the same time the insulation has been improved. Oil insulated voltage transformers for the higher voltage ratings have been modified so that they can be given the new "rated circuit voltages" which have been adopted as N.E.L.A. Standards. In some cases, this has resulted in a slight strengthening of the insulation. All oil insulated voltage transformers are so built that they can be shipped in oil if desired.

Westinghouse Current Transformers

Several new designs of current transformers for the lower voltages have been put on the market. These, in general, give performance suitable for the operation of a watthour meter and include mechanical features which are more convenient than the superseded design. Oil insulated current transformers have been improved in regard to their insulation and have been given the new standard "rated circuit voltage" ratings of the N.E.L.A. They have also been strengthened mechanically and their performance has been improved. It is worthy of note that current transformers built today to duplicate transformers of the same design, built several years ago, will have much better performance because the quality of transformer steel, which is available now, is much better than formerly.

Westinghouse Metering Outfits

Metering outfits have been developed for two distinct classes of service. Considerable demand has appeared for metering outfits for 6600 v. and below. Such outfits are often made in the form of weatherproof metal boxes containing standard dry type current and voltage transformers, and arranged for mounting on poles. The three phase line goes in at one side of the box and out at the other. At the bottom of the box a connection is provided where the customer can attach a conduit through which the low voltage leads may be led to the meters, which may be either in a box at the base of the pole or in any other convenient location.

The other development of metering outfits is for the measurement of power at high voltages. Such outfits have been made for use on circuits with grounded neutrals up to 220 kv. rating and for circuits up to 154 kv. in which the neutral may be either grounded or ungrounded. Several schemes of connection have been used for such metering. One scheme which is frequently used is to mount one current transformer and one

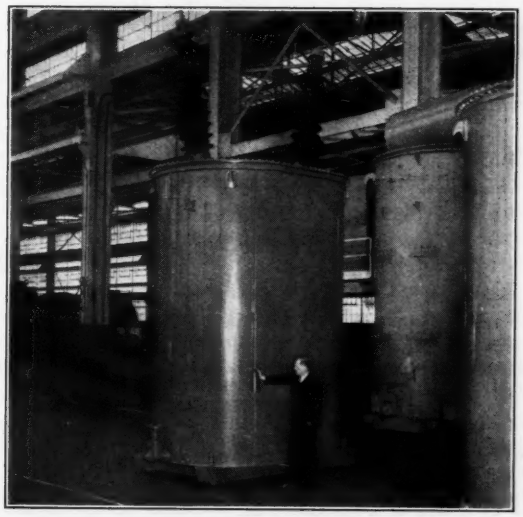


FIG. 2. WESTINGHOUSE SINGLE PHASE METERING OUTFIT FOR 220 KV.

voltage transformer in a common tank. Two or four leads from the current transformer are brought out through one high voltage bushing and one side of the voltage transformer winding is connected to one of these leads. The other side of the voltage transformer winding is brought through a separate bushing for connection to the neutral of the system. Three such units are required for the complete measurement of the three-phase system. Other arrangements house all the instrument transformers in a common tank. They may use a polyphase voltage transformer and two or three current transformers according to the service to which they are to be applied. A high degree of accuracy is obtainable in the instrument transformers in any one of these schemes.

Willians' line used in studying the performance of steam engines and turbines is obtained by plotting the total steam consumption against the load or output. Except for heavy overloads, it is a straight line and an analysis shows that the steam consumption is made up of two parts a constant which takes care of the friction load and a part that vanes directly with the next power output.

Electricity---What It Is and How It Acts*

PART XXXIII. WHY RADIATION? WHY WAVE MOTION IS MORE EFFECTIVE IN PRODUCING ACTION AT A DISTANCE THAN A STEADY DISPLACEMENT. BY A. W. KRAMER

IN THE SIMPLE oscillator and resonator of Hertz described in the preceding article[1] we possess the primary elements of a system of wireless telegraphy or radio communication. Wireless telegraphy had been thought of before the experiments of Hertz but no system devised up to that time gave any hope of success. All of them were based upon either electric conduction through the earth or upon magnetic induction; therefore, the distances over which they were effective were extremely limited.

Although it may not have been evident from the first, the experiments of Hertz opened up entirely new possibilities for the development of wireless systems, for

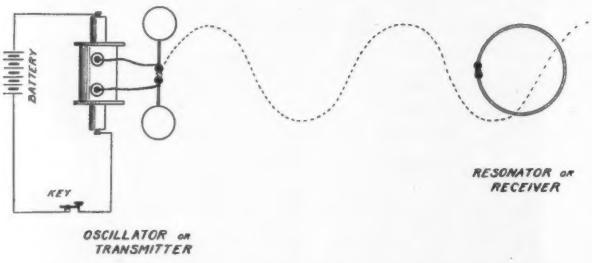


FIG. 1. SIMPLE HERTZIAN OSCILLATOR AND RESONATOR CONSTITUTE PRINCIPLE ELEMENTS IN A SYSTEM OF WIRELESS TELEGRAPHY

In this diagram a simple oscillator excited by an induction coil is controlled by a telegraph key in the primary circuit of the induction coil. When the key is pressed, electromagnetic waves produced by the oscillator induce an oscillatory current in the distant resonator. A spark produced in the spark gap of this resonator gives evidence of the existence of the waves and by means of a suitable code, messages can be transmitted over a system of this type.

in these experiments we possessed a new means for producing action at a distance. Within a few months after their presentation, Hertz's experiments were repeated all over the world. The resonating circle of Hertz was soon displaced by "detectors" of immensely greater sensibility such as the coherer of Branly. One of the most energetic and effective of the workers who established the analogy between electric waves and light waves was Professor A. Righi of Bologna.

One day a young man by the name of Marconi called at Righi's laboratory and asked how one could increase the distance at which electric waves could be rendered detectable. Hertz's experiments involved distances of only a few feet. Righi's reply to Marconi was, "Make your oscillators longer." Present day development of short-wave radio, of course, has shown this reply to be not exactly in accordance with facts but at that time it proved to be a good suggestion, for Marconi, following the clue, was able to bridge the English Channel in 1899 and in 1901 he succeeded in sending regards from England to Newfoundland. Such, briefly, is the history of modern wireless or radio-telegraphy.

We have now described the two fundamental factors in the radio transmission of energy: first, production of high-frequency oscillatory currents in suitable conductors and second, the mechanism of electro-magnetic radiation from such conductors into space.

To those unfamiliar with the classic laws of electric and magnetic fields as taught in electrical engineering schools of some years back, the simple explanation of electromagnetic radiation given in Chapter XXXI[2] may seem logical, but to many who received their electrical education before the development of modern radio, the explanation, no doubt, is somewhat mystifying. It was shown that a wave or pulse of energy travels outward from the radiating conductor never to return. Yet, according to the laws of electric and magnetic fields which we discussed in previous articles, no such action as that described in Chapter XXXI takes place.

It will be recalled that the production of electric and magnetic fields required the storage of energy in space. Before a charge or current reaches a steady state, electric and magnetic fields must be established. This requires an expenditure of energy. This energy we learned, however, is not lost; it is merely stored up in the space surrounding the conductor and all of it is returned to the system when the currents or charges producing these fields are reduced to zero. According to the laws governing the production of the electric and magnetic fields, all the energy represented by them could be accounted for; there was no indication that any portion of this energy separated itself to travel off as a wave into space. The electrical engineer, therefore, is justified in feeling that there is a discrepancy between the laws of ordinary electrical engineering and those governing electro-magnetic radiation of energy.

Even in dealing with alternating currents of the frequencies usually employed in commercial light and power service, he found no evidence of radiation phenomena. Every alternating conductor has an alternating electric and magnetic field surrounding it, but there was never any evidence that a part of this field was radiated out into space. The engineer had been taught that the power required for maintaining an alternating magnetic or electrostatic field was purely reactive and that the average value of this instantaneous power was strictly zero; that is, the power delivered to the field during one-half of a cycle was returned to the circuit in the next half cycle.

Now, in studying electromagnetic wave phenomena, he finds that not only are these things not strictly true but the very factors which cause them to depart from the truth, namely the electromagnetic waves, are precisely what radio uses for producing its marvelous distant effects.

What is the explanation of this seeming paradox? Are the laws of electric and magnetic fields wrong or incomplete or is our conception of radiation phenomena faulty?

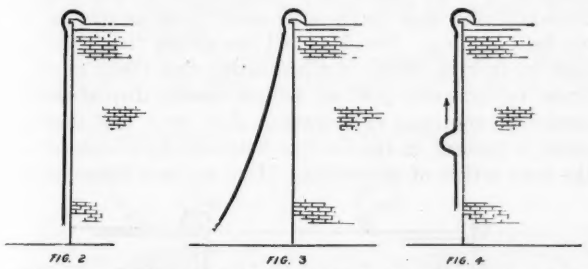
Neither. The only reason for any uncertainty or misunderstanding is due to the fact that in the past

*All rights reserved.
[1]Part XXXII, November 15, 1929, p. 1222.
[2]November 1, 1929, page 1182.

little attention has been given to the idea of displacement currents introduced by Maxwell. It is these displacement currents and their accompanying magnetic effects that cause a high frequency field to be so different in character from a stationary or low frequency electric or magnetic field.

In attempting to explain Maxwell's displacement current and how waves are produced through its relation to the magnetic field, Dr. Joseph Slepian[3] of the Westinghouse Electric & Manufacturing Co. makes use of an interesting mechanical analogy which demonstrates clearly the superiority of wave motion over the steady type of field or stress for producing distant effects. In the following, this analogy is discussed in detail.

Assume that a rope is hanging by a hook from the roof of a high building, as shown in Fig. 2, the hook being held by an inclined plane so that it will begin to move when the horizontal component of tension of the rope at the hook reaches a certain value. An electrical engineer at the bottom wishes to disengage the hook. Being familiar with the laws of electric and magnetic



FIGS. 2-4. MECHANICAL ANALOGY FOR COMPARING THE EFFECTS OF A STEADY DISPLACEMENT AND A WAVE MOTION

fields, he uses them as an analogy and starts walking slowly away from the building with the end of the rope. As he walks, he philosophizes, "I am doing considerable work and producing no effect at the hook. Of course, the work I am doing is being stored up as potential energy in the rope, for as I displace it I am raising its center of gravity. If I walk back, the center of gravity will fall again and the work done in raising it will be returned. This reminds me a good deal of the energy stored in the electrostatic field of a high voltage transmission line. While the voltage is rising, the energy of the field is increasing and the generator must supply power but when the voltage falls again the energy is all returned to the line and power is fed back to the generator. Well, I am storing energy in this rope and if I want to move that hook, I'll have to walk still farther." At this point, however, the engineer becomes exhausted and lets go of the rope. The hook has not moved.

At this point, Dr. Slepian, to prove his point, conveniently introduces a boy who has a radio transmitting station. The boy has been watching the engineer and is much astonished at his obtuseness. Coming to the rescue, he snaps the bottom of the rope out and back again as rapidly as he can, but through a distance of only a few inches. And then the engineer sees a most astonishing sight. Instead of the rope passing through a series of configurations similar to that shown in Fig. 3, and returning to its initial straight position, a bulge appears as in Fig. 4, which travels rapidly up the rope and jerks the hook free.

Naturally, the engineer starts to analyze this action. "Well," he muses, "perhaps I was wrong in likening the energy which I stored in the rope to the electrostatic energy of a transmission line, for if the rope is swung out and back rapidly enough, the power is not wattless,[4] but some energy is lost in the bulge that is produced. The bulge must have had energy in it because it kicked the hook free. Another interesting thing was that the amplitude of the bulge as it went up the rope did not fall off nearly as rapidly as the displacement produced by the slow movement. I wonder whether some law of nature isn't exemplified there."

The engineer's last thought is significant for the action just described does illustrate a broad general principle. This is to the effect that in nearly all cases of transmission of an effect through a medium, the rate of falling off with distance is less rapid with a wave motion than with a steady effect.

Although this illustration demonstrates the effectiveness of wave motion in producing distant effects, we must analyze the action further if we expect to understand why waves are radiated from a conductor carrying high frequency current. Let us follow Dr. Slepian's parable of the engineer and the boy further.

The boy, noting the engineer's dilemma, invites him to his radio station to watch him communicate with a friend several miles away. Knowing little about radio, the engineer is curious to know how high a potential must be induced in the friend's antenna in order that communication may be established. Upon learning that only a few millivolts are necessary, the engineer takes his pencil and paper and begins to calculate. He knows that the electrostatic field around the sending aerial looks something like that in Fig. 5 and that the electric intensity of such a field falls off as the cube of the distance from the charged aerial. The result astonishes him.

"Why, boy," he exclaims, "to produce a few millivolts in your friend's antenna requires that you charge your sending aerial to millions upon million of volts. The boy smiles and then calmly proceeds to apply only a few thousand volts of high frequency to his aerial and talks to his friend.

Again the engineer is mystified, for it seems that his theories are all wrong. But he remembers the incident with the rope and begins to see light. He recalls the fact that energy was carried away by the bulge in the rope and reasons that perhaps the charging of an aerial or transmission line is not essentially different from the swinging of the rope. Perhaps, if the frequency is high enough, the charging current of an aerial or transmission line is not all wattless and that some of it is radiated out into space at the expense of the electromagnetic field. Certainly, the boy's demonstration seems to prove this. But if this is true, what explanation is there for it? Why, by the laws with which he is familiar, will merely raising the frequency change the character of the field from the steady type of Fig. 5 to a type of wave motion?

[3]The Electric Journal, August, 1922, p. 335.

[4]Wattless power or current is a term used generally in alternating current circuits and refers specifically to the current which is delivered to the system during one-half of a cycle to establish electric and magnetic fields and which is returned to the generator in the succeeding half cycle by the collapse of these fields. Since this power does no work, it is said to be wattless.

Let us see if, by analyzing conditions in the rope episode, we can throw some light on this mystery. When the engineer took hold of the lower end of the rope and moved it outward, he produced a displacement along the entire length of the rope. This displacement decreased rapidly as the distance from the lower end increased but the movement of each portion of the rope along its entire length kept exact time phase with the movement produced at the lower end; at least, so it appeared to the engineer. While this was nearly true for the slow motion produced by the engineer, it was decidedly untrue for the rapid motion produced by the boy.

What the engineer failed to take into account was the fact that the rope has distributed mass. When the boy moved the rope rapidly to one side, he not only stored potential energy in the rope but also produced some kinetic energy. When the boy swung the end of

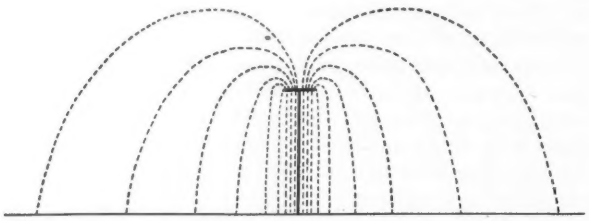


FIG. 5. THE ELECTRIC FIELD AROUND A CHARGED ANTENNA

the rope out, the first effect of the mass of the parts of the rope just above was to cause them to hang back, so that when the lower end had reached the extreme position to the left, the portions above had not yet moved. At the time the boy's hand started to move the end back to the right, the portion A in Fig. 6 had considerable velocity, therefore (because of the mass) kinetic energy. As the boy's hand swings back, the part A, because of the inertia, still continues to move to the left, in spite of the inward pull of the boy's hand below and the straight part of the rope above. In this manner, when the boy's hand returns to the wall a bulge exists in the rope.

This bulge we know travels upward. In Fig. 7, the part B, due to the kinetic energy it possesses, is moving outward against the pull of the part A. The velocity of part B, therefore, is being reduced but since this velocity cannot be reduced to zero instantly, it continues to move outward until it reaches the distance C from the wall. If A is pulling on B, however, then B must be exerting an equal pull on A and thus gradually imparts to A an outward velocity. In a similar manner, the inward pull of the part D upon C starts C on its inward course.

From this, it is evident that the energy is gradually transmitted from one part of the rope to another and a bulge travels up the rope. The action depends upon the fact that the parts of the rope themselves have inertia. If the rope had no distributed mass, the action just described would not take place; the heavier the rope, assuming a certain degree of flexibility, the more effective the action with a given velocity.

It will be seen that, with a given rope, the effectiveness of the boy's method of removing the hook lies entirely upon the rapidity of motion imparted to the rope. If the rope is moved back and forth slowly, the inertia of the rope does not come into play but as the frequency of motion is increased, the effect of inertia becomes more and more noticeable and the wave motion more effective.

Now we begin to see why it is, in the case of a wireless antenna or a transmission line, that the frequency of the current is such an important factor in radiation phenomena. For the electrical case is similar to that of the rope. The displacement of the rope corresponds with electric gradient or force for the antenna. In attempting to remove the hook from the top of the building, the engineer did not take into consideration the fact that the parts of the rope had inertia. He assumed that all points along the length of the rope moved in and out in exact time with the end of the rope and, for the slow movement he used, this assumption was correct. When the boy applied a rapid motion, this was no longer true, as has been shown. In the latter case, an increasing displacement tended to keep increasing and a wave motion resulted.

A similar condition holds true for the electrical circuit although this is not generally known. It is usually assumed that all points in an electric field vary simultaneously and that there is no such thing as inertia of the field of force. But Maxwell has shown that there is such an inertia effect. An increasing flux tends to continue to increase, just as an increasing displacement tended to continue to increase. Just why this inertia effect is present in the electric field will be discussed in the next article of this series. Here we have endeavored

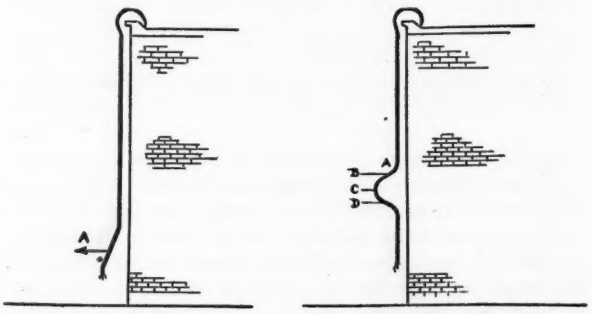


FIG. 6 FIG. 7

FIGS. 6-7. DIAGRAM ILLUSTRATING THE MECHANICS OF WAVE MOTION

to show how in a purely mechanical system, by merely increasing the frequency, a steady displacement changes to a wave motion with a considerably increased distant effect.

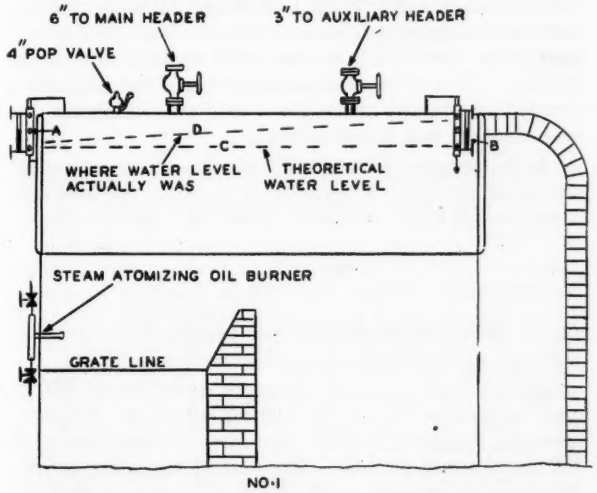
If the idea of the electromagnetic wave presented in Chapter XXXI and depicted graphically in Fig. 3 of that chapter, is kept in mind, the similarity between the bulge in the rope and the bulge in the line of electric force will be evident, and if the line of force is assumed to be endowed with distributed mass, no difficulty will be experienced in accounting for the propagation effect.

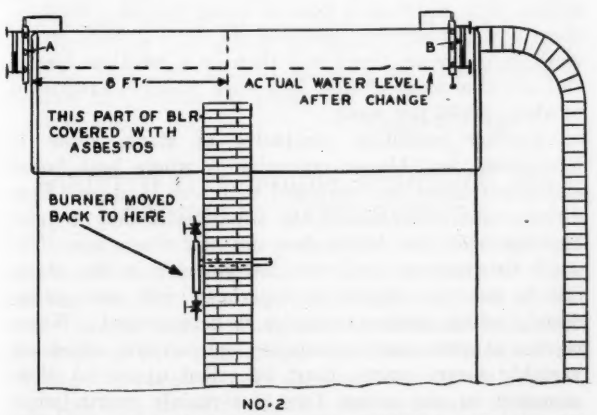
IN ALL ENGINEERING problems, the units of distance, force and time are used. In English speaking countries, the foot, pound and second are commonly used, while in most of the other parts of the world and in all scientific work the centimeter, gram and second are the units used. These two systems are commonly designated by their initials as f.p.s. or c.g.s. system.

Incorrect Burner Setting Causes Boiler to Foam

RECENTLY, an acquaintance told me of a job on which he was sent, where as shown in sketch No. 1, the 72-in. by 18-ft. boiler was of the return tubular type, set in the usual manner and fired with oil, using a steam atomizing burner.

Trouble was experienced constantly with foaming and with water being carried over continually into the engine in large quantities so that it was impossible to drain it fast enough to remove the impending danger of rupture of engine parts. Also, the water level fluctuated dangerously. The engineer tried various methods to overcome the trouble. Finally, he hooked up a water column as illustrated at B and found that, as illustrated in the sketch most of the time, the water level, instead of being at C as shown by water gage A, was, from 4 to 5 in. higher at B in the rear end, than at A in the front end as represented by the dotted line D.





CHANGE OF LOCATION OF OIL BURNER AND OF ARRANGEMENT OF BOILER SETTING OVERCOMES FOAMING TROUBLES

Blowing down, washing out and various other methods were tried without satisfactory results. Finally, the burner was moved back about 6 ft. or one-third of the length of the boiler. Results were immediate and so gratifying that the brick setting was changed as shown in sketch No. 2. That portion of the shell which projected beyond the burner was covered with 3-in. thick asbestos. After the changes were made, except for the natural fluctuation due to the circulation of the water in the boiler, the water level was found to be the same at A and B. Also, after the change, it was found that more load could be carried and less oil was burned than before.

In another case where a chain grate stoker was used, the same trouble was encountered. In this case, the remedy was slightly different. Instead of moving the stoker back, an ignition arch was built over the stoker the full width of the furnace and as long as the grate.

Minneapolis, Minn. FRED S. RUTLEDGE.

Coal Density in Coal Piles Varies Considerably

METHODS OF calculating the volume of coal in a storage pile, as published on p. 1133 of the Oct. 15 issue by Mr. Ogur, are very interesting and I hope to have a chance to use them sometime if ever again I get to where they have storage piles bigger than the kind that one often looks at about noon time on Saturday in order to estimate whether there is enough to last over until Monday.

Accuracy in volume determination, however, is something of which I have always been a little skeptical. Undoubtedly the volumetric measurements can be made accurately, the trouble lies in the proper coal densities to use. Usually the first thing an engineer will try to use for this purpose is a 5-gal. can. By the time he fills and weighs this several times, he will doubt his ability

to get a representative sample. He looks therefore for something bigger and finds a barrel to be handy.

Some years ago, I had occasion to believe that the figures we used for the coal in storage were too high. We kept an accurate record of the coal burned and coal received and, figuring in the inventory values, we were getting either a lot of coal that we were not paying for or we were getting an unusually high efficiency. About the same time, there was an argument as to whether or not the size of the coal made any difference in the weight of a cubic foot, which involved a question as to whether or not the larger voids in the larger sizes were balanced by the greater density of the lumps.

Small samples taken in 2-cu. ft. boxes gave values from 59.3 to 61 lb. per cu. ft. This was run-of-mine coal having about 13,500 B.t.u. per lb. In order to check this, I kept track of the net weights and net volumes of a number of cars and got the average figure of 56.5 lb. per cu. ft. instead of about 60 by the small measure. This is a difference of about 7 per cent, which is far from a negligible factor. The weights as measured on our own scales and volumes as measured by our men are as follows:

Car	Net Wt. lb.	Net Vol. cu. ft.	Density lb. cu. ft.
1	107,700	1890	56.9
2	107,100	1926	55.6
3	109,400	1928	56.8
4	109,200	1940	56.4
5	109,500	1929	56.7
6	109,300	1915	57.1
7	107,100	1910	56.1

Shortly after this, we changed our coal, getting a 10,500-B.t.u. coal which, by the same method, gave an average of 54.1 lb. per cu. ft. Average weights of this kind are handy not only for estimating storage piles but also in calculating bin sizes. Handbook values are not of much value unless you know all the conditions under which the data was collected.

Brooklyn, N. Y. P. F. ROGERS.

Analysis of Records Aids Soot Blower Operation

SEVERAL YEARS ago, the question was: Are mechanical soot blowers justified? Today the questions are: Do we get the most out of our soot blowers; are our soot blowers giving us the utmost life; are they using excessive amounts of steam and are we operating our blowers often enough or too often? The problems today are those dealing with operation and efficiency. It is, therefore, to other operating engineers that one must turn for the information by which it is possible to compare performances.

Stack temperature is a good barometer for indicating the effect of blowing soot, decrease in stack temperature indicating benefit from soot removal. Unfortunately, many plants have no stack thermometers or pyrometers, so do not know how often soot should be blown or the beneficial effect of blowing soot. In such plants, soot removal is a matter of guesswork both as to the frequency and length of blowing. Guesswork is wasteful, for soot blowers operated either too often or too seldom, in the one instance, to waste of steam through the blower element and in the other, due to waste of fuel in the furnace because of a decrease in heat transfer from furnace gases to boiler.

It is generally understood that the front rows of tubes of a boiler do the most work. They are subject to the direct impingement of fly ash as well as to adherence of carbon and soot, therefore the front tubes should be blown more often than the rear tubes. Moreover, since the deposits on the front tubes tend to build up thicker and quicker, the soot blowing element, serving the front rows of tubes, should be operated not only oftener but longer than that for rear tubes. Yet, how often is this done? Granting that the elements cleaning the front rows of tubes should be operated longer and oftener, will it suffice to operate them twice as often and twice as long?

Without a stack thermometer, it is impossible to collect necessary data by which to determine the proper frequency and length of blow, which should be based upon the amount of coal burned in a given time. Besides use of a thermometer, it is necessary to determine the steam flow under varying conditions of operation, in order to determine the most economical use of soot blowers. It is difficult to use a steam-flow meter because a flow meter of the usual size required in a power plant, will hardly indicate a noticeable change in steam flow when a soot blower is put in or out of service. Moreover, an indicating steam flow meter fails to give the data needed since it is not the rate of steam flow at any instant but the total flow from start to finish that is important. Difficulties of condensing the steam and measuring it are many, hence, for a majority of plants, the condensation test is impractical.

It is possible to calculate the steam consumption according to Napier's formula as given in the following equation but there are some errors that enter in its use.

$$W = \frac{P\ A}{70}$$

where: W = lb. steam flow per second; P = absolute pressure per sq. in.; A = area of orifice in sq. in.

Suppose there are 12 elements operating at 250-lb. gage pressure with steam costing $0.45 per thousand pounds. Suppose, further, that each element consumes 400 lb. of steam per min. The cost of steam for operating these 12 elements, is $2.16 per min. with all elements in operation. If 30 sec. time instead of 60 sec. would suffice, then $1.08 each time is being wasted. Suppose these soot blowers are operated six days a week, every week in the year, there will then be a needless loss in this one item alone of $336.96 a year, which is equivalent to about $6.48 per week.

Another condition conducive of steam waste in mechanical soot blower operation is where both boiler and superheater are equipped with soot blowers. Conditions often arise where the superheater may require blowing while the boiler does not and vice-versa. The stack thermometer and the thermometer in the steam line to show the degree of superheat, will show immediately which elements require to be operated. Where neither thermometer is installed, guess-work, which invariably means waste, must be relied upon. A thermometer in the steam line is certainly worth while wherever a superheater is used. A drop in superheat of 25 deg. F. within 40 hr. of continued operation is not

uncommon where no soot blowers are used. The thermometer immediately brings this situation to light, enabling a more uniform degree of superheat to be maintained and permitting the soot blowers to be operated effectively.

Many engineers look upon the deterioration of their blower elements as inevitable. Ultimate deterioration is inevitable but much can be done to increase the life of elements.

While the heating and warping of certain elements cannot be prevented, due to their location, water and moisture in the steam and the collection of slugs of water can be prevented by careful installation and adequate drainage. Condensation and wet steam often increase soot blower maintenance cost much more in one plant than another, although the two sets of soot blowers may be operating under what appear to be identical conditions.

Records of soot blower replacements, showing which elements fail most often, how long they lasted and the causes of failure, furnish information which leads to possible improvement. Mechanical soot blowers are valuable for bettering power plant operation but they may be a source of expense.

It would be interesting to know what engineers are doing to check up their steam consumption in this connection or keep records of the life of the various elements. It would be interesting to know how others check deterioration and failure by analyzing them and logging performance and operation. Surely something is being done. Let's hear about it.

Chicago, Ill. C. G. Crowley.

Bearings Cooling Water Tapped Direct from Pump Saves Power

Cooling water for oil bearings on heavy-duty centrifugal pumps, when secured directly from the pump, results in a direct saving and assures uninterrupted supply to each pump in the main pumping station of the Springfield City Water Co., Springfield, Missouri.

This saving has been accomplished by tapping the first stage of the two-stage centrifugal pumps and using this water for cooling the bearings. Normally, the pumps operate under 155 lb. press., the pressure in the first stage being approximately 77 lb. Furnishing the water from this stage, instead of taking it from one of the service lines in the building, makes the supply independent and economical. A check valve is placed immediately on the line which is tapped into the pump to prevent back flow and to act as a seal when using a vacuum in starting the pump.

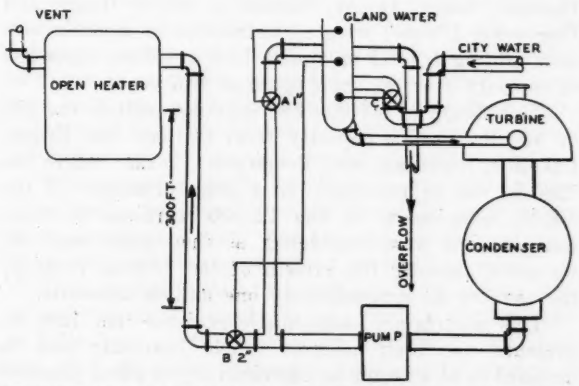
Springfield, Mo. William J. Gray.

Gland-Water Supply Improved by Changes in Arrangement

When our turbine was installed, the engineer had considerable correspondence with the manufacturer regarding the size, capacity and location of the gland-water supply tank. Considerable difficulty had been encountered with poor gland water on older machines where jet condensers were used and condensate was not available and the chief decided that he would eliminate this difficulty by hooking the new unit up so that condensate from this new unit, which had a surface condenser, would be supplied to the glands of all the machines.

When the matter was finally settled, it was found that the tank should have been placed about a foot higher than the open heater into which the condensate pump discharged. This would have meant a constant throttling of the line in order to force the water up into the gland tank, so it was decided to compromise the matter and put the tank at the same level as the heater as shown in the diagram, on the assumption that the friction on the relatively long line to the heater would be sufficient to force the water into the elevated tank. Fortunately this condition prevailed at most loads but, when the load was low at night, no water would flow into the tank, so a small float was installed to admit city water into the tank at such times.

For a while this worked all right but eventually the glands scaled up, because of the small amount of city water introduced. In order to avoid any possibility of



PROPER INSTALLATION OF WATER SUPPLY TANK AND OF FLOAT VALVES RESULTS IN IMPROVED GLAND WATER SUPPLY

trouble in the future, the engineer installed a float-operated valve in the discharge line of the hotwell pump, but outside of the other small line going up to the tank as shown in the sketch. The tank then had three such floats set at different levels, the top one A controlled the line to the tank. When this valve was open, if the level of the water continued to drop, the second valve B operated and began to close the valve in the line to the feedwater heater. Electric contacts were arranged on this float to ring a bell when the valve was entirely closed. If the level in the tank still continued to drop, the third float C opened up the city water line. This, however, was needed only when the new turbine was not in operation.

Brooklyn, N. Y. F. Paul.

Correction Note: In the report of the Fiftieth Annual Meeting of the American Society of Mechanical Engineers, appearing in the January 1 issue, it is stated in the last paragraph, column 1, page 80, that A. E. Flowers and M. A. Dietrich are associated with De La Vergne Separator Co. This was in error as these gentlemen are with the De Laval Separator Co., Mr. Flowers being in charge of engineering of development and Mr. Dietrich is in the process laboratory of this company.

Editorial Comment

The Growth of 1200-Lb. Stations

Although we may wonder what the final outcome of the high pressure and high temperature situation may be, there is no overlooking the rapid, in fact phenomenal, growth, of 1200-lb. stations. Starting in a modest way at Edgar station in 1923, it was over two years until the second and still larger unit, was purchased for Lakeside. It was not until the second unit, rated at 10,000 kw. was installed at Edgar in 1927, however, that we had any evidence that 1200-lb. turbines were being taken seriously by the American industry.

The second Lakeside unit, Northeast, Deepwater, Holland, South Amboy, Station A, River Rouge and Deepwater (Texas) were all announced in rapid succession, adding a total of almost half a million kilowatts of capacity over the short space of two years.

This figure of 500,000 kw. does not include the 350 or 400 lb. turbine capacity from stations like Edgar, Lakeside, Northeast, and Deepwater (Texas) where the 1200-lb. was superimposed on a lower pressure. If the 400-lb. complement of the 1200-lb. turbines at these four stations were considered, as they might well be, we could consider the growth of the 1200-lb. cycle in the country as approximately one million kilowatts.

This is certainly indisputable evidence that 1200 lb. pressure has been accepted whole heartedly and is destined to be a factor in American power plant practice for many years. Furthermore the wide distribution, Massachusetts, Wisconsin, Missouri, Delaware, New Jersey, California, and Texas, shows that this growth is due to practical advantages and not the result of either geographical conditions or financial alliances.

Correct Sizes

As a science or rather as an application of science, engineering has progressed to the point where we like to think that all the problems we meet can be solved by the application of the proper formula and a slide rule.

After completing the calculations and adding anywhere from 100 to 300 per cent as a factor of safety, it is considerable satisfaction to lean back in the chair with a "cat that ate the canary" expression.

Recently, while discussing the proper rating to use with a certain type of pump in order to bring the equipment of all manufacturers on a common basis, an engineer stated that the exact size or determination of capacity had little application because the pumps actually used were many times larger than necessary, that size was determined by what had actually worked out in practice and finally that such pumps were always installed in duplicate anyway.

Such an attitude is not, of course, conducive to progress in either design or development: it complicates installations with inefficient, oversized apparatus, while the results from such cut and try engineering installations are of little use in analyzing new installations.

To be of real engineering value, not only the performance of each piece of equipment over the entire range of operation must be known, but some standard of comparison must be set up so that results from one test or installation can be applied to the design of another installation in some rational manner.

Of course it is better to be safe than to be sorry but engineering development is measured by the tolerance allowed in the ever present "factor of ignorance" which the engineer cannot neglect. The smaller the factor of ignorance the better the quality of engineering. Little power plant equipment is purchased today on a weight basis. There is even less excuse for purchasing it simply because that size was used by John Smith.

The Greatest Value of Research

To the pure scientist, the search for the truth, regardless of its applications in the affairs of men, is the primary consideration. To the industrial research worker, the adaptation of the discoveries of pure science to increasing the business of his company is his principal concern. That these two types of research are of incalculable value to industry is almost axiomatic at the present time.

"But if we confine our estimate of the importance of industrial research to survey of material benefits, we lose sight of what may well be its supreme achievement," says Dr. W. T. Whitney, director of the General Electric research laboratory, in a paper presented at the World Engineering Congress in Tokio. "For industrial research affects our creeds. Biology shows us how far we have come from the amoeba and shows us, too, the kind of co-operative effort that insured the advance. We may believe, therefore, that when research is utilized by all industries, natural byproducts will be further mental development, more serviceable idealism, fuller understanding among peoples and better direction of the affairs of nations. What is being learned from science, specialized for industrial needs—is, that impartial and truthful experiment is more serviceable than any amount of emotional persistency or unemotional fixity."

Strange as it may seem, some things are more important than industry. Human life itself and the relations between human beings are the really important things; in its fundamental aspect, industry is but a means to an end—the preservation of the physical existence of the species.

Now the function of research in industry is constantly to make industry curious, to make it ask, Why? Why? at every turn, to make it skeptical, to make it refuse to be satisfied with itself, to make it ever look forward to better ways of doing things.

There is some danger in this, of course. Suppose any great number of people begins to ask, Why? Why? in regard to our political affairs, our financial relations, our domestic relations, our methods of living as people rather than as part of a production system. To apply

to these fields the same type of research that has proved so successful to industry presupposes a quality of leadership in politics, in finance, in law, in sociology, similar to that typified by Dr. Whitney himself. Does such leadership exists today? If so, the human race does not seem to be willing to accept it to the extent of trusting it with control of the race.

It remains to be seen whether the research type of thinking can solve the problems involving intangible human values as well as it solves problems involving physical materials. It is certain, however, that every day a few more laymen begin to ask, "why?", about something they have hitherto taken for granted in their daily affairs. That much, at least, might be called progress.

Off Duty

Twelve years have passed since the close of the World War. Twelve years spent in readjusting ourselves to new economic conditions and in trying to find out what it was all about. Today, everything seems quite settled and we go about our business much as we did before the war. These years of peace have done much to heal the wounds of the world and except for alterations in geographical boundaries of certain countries and in the different economic conditions existing, the war might be forgotten and its heroes basking in the sunshine of glory with the heroes of other conflicts.

But such, strangely enough, is not the case. The war is not forgotten and its heroes are singularly silent. War, today, is in bad repute and the universal tendency against it is one of the most remarkable aspects of the present day world, for it is a reversal of the usual processes of history. Usually we tend to glorify old, unhappy, far off things; consequently, history usually makes all ancient wars noble, justified and victorious.

Today, however, after so short a period as twelve years, we are uneasily uncertain whether the war was noble from any standpoint—certainly it was not victorious. The more we think about it, the more does the utter futility of such conflicts impress itself on our minds. True, some wars have been necessary, perhaps, and in some cases good has been accomplished, but when we review the holocaust of 1914-1918, we must search far indeed for a reason to justify the awful destruction which it incurred.

During the past two or three years, war novels have made their appearance in increasing numbers, all of them written by those who were actively engaged in the conflict but in none of them is portrayed anything but the unutterable horror and futility of it all. In none of them do we find anything but bitterness and resentment, not against the enemies they fought but could not see, but against the forces which mankind was too unwise or unintelligent to control. More often, in these books, the enemy is regarded with feelings of kindness rather than hatred. To the man in the trenches, it was more often his own superior officers whom he regarded as his enemies, for they were directly responsible for his misery. Day by day new accounts of the war appear. A Farewell to Arms, War, All Quiet on the Western Front, Zero Hour, Schlumpf, The Case of Sargent Grischa,—books written by men from both sides of no-mans-land whom the intervening years have made more fearless of opinion, but they all tell the same story—a story of four years of unutterable dreariness, misery, petty bureaucracy in high places, futile heroism, disappointment, fear, pain and disillusion.

The romance and heroism that characterized books on other wars, in these is lacking. The beating of drums, the blare of the trumpets, the cheers of the crowds which lent color to previous wars received no place in the works of these soldiers. For these men saw the misery, the suffering, the gore, not the glory; they saw its horrors, its barbarism.

The glories of war! Where is there glory in being blown to fragments by the chemists' latest invention in high explosive shells or in dying an unspeakable death by inhaling his newest poison gas? Where is there romance in weeks and months and years of shivering, hardship and pain, in cold, filthy, water sodden trenches? where is there chivalry in charging a battery of machine guns? Where is there beauty in airplanes and Zeppelins dropping bombs on babies and children?

Scientists and engineers have made a hell on earth of war. They have destroyed the chivalry, stolen the glory and killed the romance. The last war was frightful in all things—in loss of life, in suffering, in monetary loss, so much that compared to it, all other previous wars pale into insignificance. The World War which lasted 1563 days, cost almost ten million lives, and over 186 billions of dollars—*119 million dollars a day!*

What possible excuse can there be for such a state of affairs? But what possible stretch of imagination can so-called intelligent human beings engage in such damnable practice and justify it on any grounds?

There is much talk that war has always been with us and therefore always will be. Such reasoning holds as little logic as the practice of war itself. To think that man can only progress up to a certain point in building his civilization and that after a period of disaster and destruction he must start anew, is an insult to his intelligence.

Perhaps the Kellogg Pact is not feasible—perhaps it is no better than other nobly worded plans to renounce war, perhaps it may prove no more effective. Is that any reason for arbitrarily denouncing it? It, at least, expresses a will to peace and anything that does that is worth considering. While it may seem no different in its plan and purpose from other peace plans, it has this distinction; it was a gesture forced by public opinion and was kept alive by public support when officialdom would have killed it. For this reason alone, if for no other, it deserves support.

The registered progress towards a permanent peace remains small but there are many hopeful signs that the world is tending more and more in this direction. Twelve years ago the Kellogg Pact would have been unthinkable. Today some forty nations voluntary subscribe to it. The progress made in the cause of peace in the past twelve years surpasses every previous effort. For the first time in the world's history there is a "common conscience of mankind" intent upon avoiding war and realizing that peace is necessary for the development of human progress and civilization.

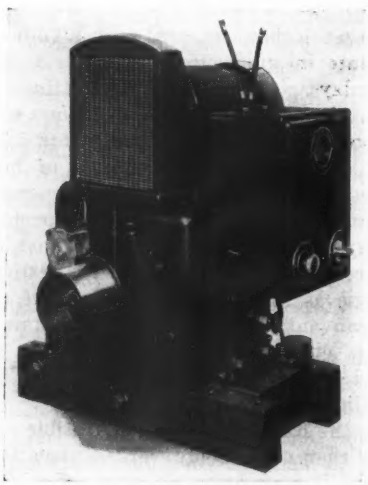
Yearly Index

INDEX for Volume XXXIII of Power Plant Engineering is now prepared and will be sent free to subscribers upon request.

Power Plant Engineering Developments and News

Light Plant for Auxiliary Service

TO MEET a demand on the part of contractors for a dependable source of power to supply illumination for night work, Fairbanks-Morse & Co., Chicago, Ill., has developed a compact self-contained light plant shown herewith. This unit is adaptable for use on



COMPLETE SELF-CONTAINED ENGINE-GENERATOR SET FOR LIGHT AUXILIARY LOADS

cranes, dredges and excavating equipment and for marine installations.

In addition, industrial plants as well as office building and hotel plants may wish to provide an economical source of power for light electrical loads during periods when the main generator is not or should not be operating. Such a unit is designed to be used to advantage to supply lights during the non-working hours as well as for emergency service.

The plant shown is designed for simplicity, sturdiness of construction, reliability and freedom from excessive maintenance and supervision charges. The plant comes in two sizes, of 750 and 1500 w. capacity, respectively. In the assembly, the power unit, the ignition system, the generator end and the control mechanism are maintained as separate units, not being tied up in any way that introduces complication. The engine used is the Fairbanks-Morse self-oiling Z engine with high-tension magneto ignition. The smaller 1½-hp. unit is designed to operate on gasoline as fuel while the larger 3-hp. engine can use either gasoline or kerosene.

The generator is a ball-bearing machine mounted as a unit directly above the engine. A Flex-Mor V belt drive is used to give great gripping power under all load conditions and positive action, thus preventing variation in the speed relation between the engine and the generator. The control mechanism is contained in the completely enclosed box mounted as a unit on the main frame. It consists simply of a push button start and a "high-low-belt" switch to permit the storage battery to be charged at a rapid rate for regular charges or a low rate for an equalizing charge.

In the belt position the generator is electrically disconnected from the engine so that the entire power output is available for mechanical work from a pulley on the engine shaft. The usual storage battery plant starts with a simple push button control; the generator acts as a motor during the starting period, no cranking being required. Ignition is furnished by a high-tension rotary magneto which is a complete generating unit in itself and entirely independent of the condition of the storage battery of the plant.

The plant is water-cooled by a radiator and fan and water circulating system similar to that employed by any automobile engine, also arranged to provide for cooling of the generator. The accompanying table gives some of the more important specifications:

Size plant, watts	750	1500
Horsepower	1½	3
R.p.m.	1500	800
Fuel tank capacity, qts.	3	8
Generator		
Power rating, watts	750	1500
Volts	32	32
	or 115	or 115
R.p.m.	3600	3000
Floor space		
Height, in.	25½	30½
Width, inc. crank, in.	23¼	30¼
Length, in.	26	32
Shipping weight, lb.	275	500

While this plant is built in two sizes, it is offered with a variety of storage battery combinations which will meet almost any demand placed on the unit for either a 32-v. or standard 115-v. circuit. For direct lighting, when it is desired to operate without the storage battery, a special control panel is provided.

Bi-Metal Bearing

SEEKING PRIMARILY to produce a satisfactory bearing metal at low cost, engineers of the Fredericksen Co., Saginaw, Mich., have developed a new type of bi-metal bearing, employing Sabeco. As described by an official

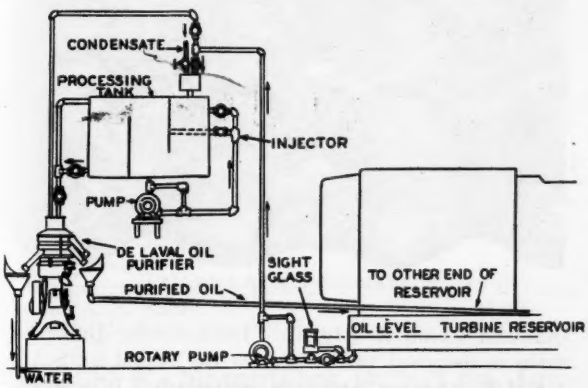
of the company, Sabeco is composed of virgin copper, tin, and lead, with a high percentage of lead alloyed by a process designed to prevent segregation of the lead as well as seizing, scoring, burning, corrosion or pounding out.

The new bearing material, which is to be known as Sabecoed Steel Bearings, consists of an outer shell of seamless steel tubing to which an inner lining of Sabeco bearing bronze is inseparably fused. Tests of the fusion of the metals have been made by bringing the entire bearing to the melting point of the bronze, allowing it to run out. Examination after cooling showed a film of the bronze adhering to the steel, clear evidence of the welding of the two metals. Further proof of this fusion is shown in machining, there being no separation of the metals in the chips.

An important claim for the new bearing material is that it possesses a low co-efficient of expansion, permitting a close fit and adding to the life and wearing qualities. At present, the minimum wall thickness in which it can be used is about ⅛ in. These bearings have been made in all sizes up to 13 in. inside diameter.

De Laval-Funk Process for Purifying Turbine Oil

DE LAVAL-FUNK PROCESS for maintaining the purity of steam turbine lubricating oil has recently been announced. Its operation is based on the fact, now generally accepted by lubrication engineers,



FLOW DIAGRAM OF DE LAVAL-FUNK PROCESS

that sludge is the real troublemaker in turbine lubrication and that the formation of this product is greatly accelerated by the presence in the oil of water and oxyhydrocarbons, commonly referred to as acidity.

De Laval-Funk process is intended to prevent the formation of sludge within the turbine lubricating system. To do this, oil is brought into contact with condensate under conditions favorable to the formation of sludge and the absorption by the condensate of oxyhydrocarbons. The mixture is then separated and purified by means of a De Laval oil purifier especially designed to meet the conditions.

In the operation of the process, a stream of oil is continuously drawn from the bottom of the turbine reservoir into a specially-constructed processing tank, where it is intimately mixed with condensate and thoroughly agitated by a pump. This treatment subjects the oil to a condition far more favorable to the formation of sludge outside the main lubricating system than any condition which exists in the turbine itself. Hence, the sludge resulting from the combination of oxyhydrocarbons and water is formed in the processing tank rather than in the turbine.

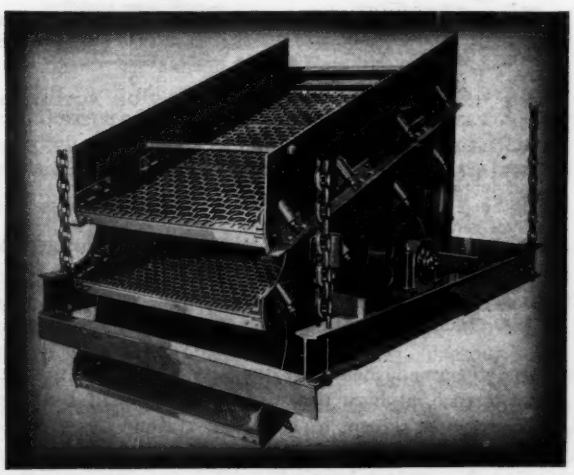
Equipment used with the process may be installed either in the turbine room or below the unit. The illustration shows it in the turbine room.

Oil is continuously withdrawn from the bottom of the turbine reservoir, either by a pump or gravity flow, through a sight-glass, the outlet point of which is level with the minimum oil level in the turbine reservoir. This oil flows into the top of the processing tank; at the same time, a small stream of condensate enters the tank at the same point. This incoming mixture of oil and condensate is brought into intimate contact by baffles, agitator-pump and mixing nozzle, as shown in the processing tank. The mixture of oil and water gradually finds its way to the top of the last baffle, from which it overflows to the purifier and, from this point, clean oil, as has already been stated, is discharged into the turbine reservoir.

The sight overflow glass is bypassed with a valved line so that the turbine reservoir may be completely drained and the entire contents purified, if desired. Installation of a lock valve on this line insures against accidental drainage of the reservoir through carelessness. A valve is also installed on the line leading from the sight overflow to the processing tank so that this tank may be cut out of the system in case the turbine develops a bad water leak and it becomes desirable to increase the rate of flow through the purifier.

Vibrator Screen for Separation of Aggregates

FOR YEARS, builders and users of separation machinery for the screening of bulk materials have appreciated the advantages of continuous and rapid agitation of the aggregate for the purpose of causing the smaller size lumps to settle through the mass and pass the screen surface openings. High-speed pulsation causes constant shifting of the mass of material and aids



VIBRATION SCREEN FOR HEAVY DUTY SERVICE

in contacting all the aggregate with the screening surface.

In the production of labor-saving machinery for handling bulk products, the Stephens-Adamson Mfg. Co. of Aurora, Ill., announces the S-A vibrator, a power actuated screen designed and built to give satisfactory separating service through long periods. Positive vibration has been incorporated as a fundamental feature, also ability to withstand the constant vibration during the life of the equipment.

Screens are built in different widths and lengths ranging from 2 ft. wide by 4 ft. long to 5 ft. wide by 8 ft. long, all in single, double and triple deck assemblies. Four different rotor mechanisms are built for installation in the several assemblies selected according to the severity of duty.

Farval System of Lubrication

FARVAL SYSTEM, shown in the illustration, is designed to be a positive, centralized system of lubrication for many types of industrial machinery. It is intended as a positive, mechanical method of delivering a predetermined, measured quantity of lubricant, either oil or grease, at high pressure to all types of bearings. It consists, as shown, of a central station (compressor, reservoir and gage), a single main pipe line and an automatic valve at each bearing.

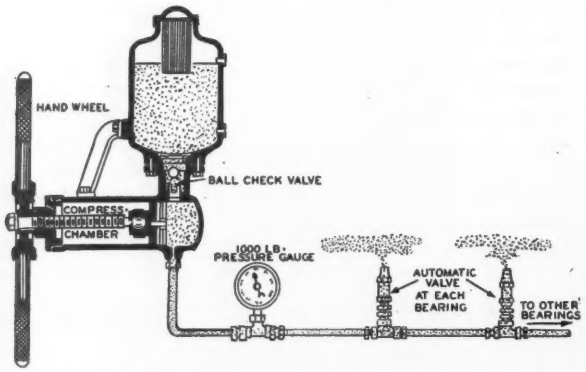


FIG. 1. GENERAL ARRANGEMENT OF FARVAL SYSTEM SHOWING RESERVOIR, COMPRESSOR, GAGE AND AUTOMATIC VALVES

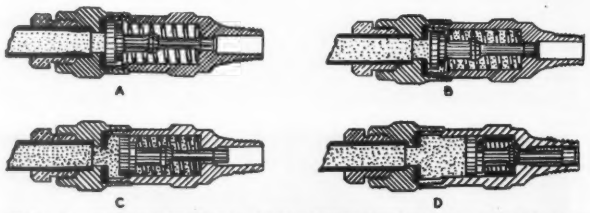


FIG. 2. CONSTRUCTION AND OPERATION OF AUTOMATIC VALVE, SHOWING SEQUENCE OF MOTIONS

A—Valve in normal position with no pressure on line. Piston is seated against copper gasket, closing supply line, which is always full of lubricant.

B—Supply line pressure has moved piston forward so that lubricant can fill valve chamber.

C—Pressure continues to move piston forward, closing intake and outlet, thus loading valve with measured charge.

D—Further pressure forces piston forward until the smaller valve seats, thus shutting off the flow and discharging measured quantity of lubricant to bearing.

Designed to exert 1000 lb. pressure, the central station compressor, Fig. 1, may be controlled either by hand or automatically. The reservoir, a unit with the compressor, is supplied in sizes to fit the job. The gage is connected to the main supply line near the compressor and when the gage registers 1000 lb., the operator knows that all the valves have functioned. From the central station, the system can be "shot" in less than two minutes.

Single main pipe line supplies lubricant to the automatic valves at each bearing; this system is designed to obviate the necessity for a separate line from compressor to each valve. All copper tubing is installed so that it cannot be damaged by the operation of the machine.

The automatic valve, Fig. 2, is designed to provide positive control of lubricant at the bearing by measuring the lubricant, forcing it into the bearing and then shutting off automatically. Each valve is arranged to operate independently of the others and to be positive in action regardless of the condition of the bearing.

The Farval system is a product of Lubrication Devices Incorporated, 50 S. Washington St., Battle Creek, Mich.

Roller Chain with 2½-In. Pitch

TO MEET the demand for a heavy, large pitch roller chain, the new 2½-in. pitch chain shown in the accompanying illustration has been developed by the Diamond Chain & Mfg. Co., Indianapolis, Ind. This chain is designed to conform to the A.S.M.E., S.A.E., A.S.M.A., and the American Standards. It is similar to all Diamond roller chain in design but made for heavy-duty applications such as large conveyors, industrial locomotives, and the like. For single strand chain, the average tensile strength is 95,000 lb.; maximum hp., 97 with 19-tooth sprocket; maximum r.p.m., 240. It is made in single and multiple strands, transmission capacity and tensile strength being proportional to the number of strands.

DIAMOND ROLLER CHAIN

PHILADELPHIA SECTION of the American Society of Mechanical Engineers will meet on January 28 at the Bellevue-Stratford Hotel, Philadelphia, Pa., at 8:00 p. m. At this meeting, W. E. S. Dyer, consulting engineer, is scheduled to discuss the Pioneer High-pressure Industrial Plant of America. Description is to be given of the 1840-lb. pressure plant, using reciprocating engines, for the Philip Carey Co. at Lockland, Ohio.

A. S. H. & V. E. to Meet January 27-31

FOR THE 36th annual meeting of the American Society of Heating & Ventilating Engineers, to be held at Philadelphia, Penna., January 27-31, an extensive program of technical papers and entertainment features has been announced. Entertainment, teas, bridge and trips for the ladies, luncheons, banquets and trips for the men are some of the features. Headquarters and registration will be at the Benjamin Franklin Hotel. R. C. Bolsinger is general chairman of the committee in charge.

During the time of the convention, the First International Exposition of Heating and Ventilating Equipment is to be held at the Commercial Museum of Philadelphia.

Complete list of the technical papers announced for presentation in addition to reports of various committees, is as follows:

Tuesday, January 28:

Power from Process and Space Heating Steam, by L. A. Harding.

Pressure Difference Across Windows in Relation to Wind Velocity, by J. E. Emswiler and W. C. Randall.

Air Infiltration Through Brick Wall, by G. L. Larson, D. W. Nelson and C. Braatz.

Wednesday, January 29:

Surface Transmission Coefficients, by Rowley, Algren and Blackshaw.

Absorption of Solar Radiation in Its Relation to Characteristics of Absorbing Surface, by F. C. Houghten and Carl Gutberlet.

Preventing Condensation on Interior Building Surfaces, by Paul D. Close.

Code for Testing and Rating Unit Heaters.

Method of Testing Unit Heaters Suitable for Field Use, by L. S. O'Bannon.

Measurement of Flow of Air Through Registers and Grilles, by Professor L. E. Davies.

Thursday, January 30:

Rating of Heating Boilers by Their Physical Characteristics, by C. E. Bronson.

Some Studies of Aeration of Garages, by W. C. Randall and L. W. Leonhard.

Pipe Sizes for Hot Water Heating Systems, by Elmer Smith.

Panel Warming, by L. W. Fowler.

Friday, January 31:

Air Conditioning of the Halls of Congress, by L. L. Lewis and A. E. Stacey.

Tests of Disc and Propeller Fans, by A. I. Brown.

A. I. E. E. Nominates W. S. Lee, for Presidency

NATIONAL NOMINATING COMMITTEE of the American Institute of Electrical Engineers, consisting of 15 members from various parts of the country, has nominated the following official ticket of candidates for the offices falling vacant August 1, 1930:

For President: William S. Lee, vice-president and chief engineer, Duke Power Co., Charlotte, N. C.

For Vice-Presidents:

North Eastern District:
I. E. Moultrop, chief engineer, Edison Electric Illuminating Company of Boston, Boston, Mass.

New York City District:
H. P. Charlesworth, vice-president, Bell Telephone Laboratories, New York, N. Y.

Great Lakes District:
T. N. Lacy, chief engineer, Michigan Bell Telephone Company, Detroit, Mich.

South West District:
George C. Shaad, dean, School of Engineering and Architecture, University of Kansas, Lawrence, Kans.

North West District:
H. V. Carpenter, dean of mechanic arts & engineering and director of Engineering Experiment Station, State College of Washington, Pullman, Wash.

For Directors:

A. B. Cooper, general manager, Ferranti Electric Limited, Toronto, Ont.

A. E. Knowlton, associate professor of electrical engineering, Yale University, New Haven, Conn.

R. H. Tapscott, electrical engineer, New York Edison Company, New York, N. Y.

For National Treasurer:

George A. Hamilton, electrical engineer (retired), Elizabeth, N. J.

William States Lee was born in Lancaster, S. C., January 28, 1872, and was awarded the degree of C. E. by the Citadel, The Military College of South Carolina, in 1894; Honorary Degree of Doctor of Science, Davidson College, N. C., 1929.

Following his early engineering experience, he was appointed Resident Engineer at the Anderson (S. C.) Light and Power Co. in 1897; Resident Engineer of the Columbus (Ga.) Power Co. in 1898, and Chief Engineer of the latter in March, 1902. In March, 1903, he was appointed Chief Engineer and in October of that year, Vice-President and Chief Engineer of the Catawba Power Company, Charlotte, N. C. This company was a subsidiary of the Southern Power Co. and in 1905 he became Chief Engineer of the latter company. He later received the appointment of Vice-President and Chief Engineer, which position he held for about 15 years. He is at present Vice-President and Chief Engineer of the Duke Power Co.

Among Mr. Lee's other connections, the following should be included: President of the W. S. Lee Engineering Corp.; President and Chief Engineer of the Piedmont and Northern Railway Co.; Vice-President and Chief Engineer and Director, Duke Power Co., Wateree Power Co., Western Carolina Power Co., Catawba Manufacturing and Electric Power Co.; Director, American Cyanamid Co.; Vice-Chairman and Trustee of the Duke Endowment. He is also engaged in practice as a Consulting Engineer with an office in New York City and Charlotte, N. C.

He has been a pioneer in high voltage hydroelectric power development and transmission, and is inventor of the Lee Pin. His Institute activities are as follows: Associate 1904, Member 1907, Fellow 1913, Director 1911-14 and 1929- , and member for several years of the Committee on Power Transmission and Distribution, Standards Committee, and Committee on Power Generation, being at present a member of the latter two and of the Edison Medal Committee.

Mr. Lee's other Society memberships include American Society of Mechanical Engineers, American Society of Civil Engineers, Engineering Institute of Canada, American Electri-Chemical Society, and the American Engineering Council.

FOG, FOR THE 24-hr. period ending midnight, Tuesday, December 17, rolled up the heaviest load ever carried by the New York Edison Co. and its associated electric light and power companies serving Manhattan, Bronx, Brooklyn, Queens and Yonkers. Tuesday's output of 17,289,820 kw-hr. was equivalent to 14,408,183 50-w. electric lamps burning continuously. Figured in horsepower, it was equivalent to about 960,000 horses or figuring one horsepower equivalent to 10 men, 9,600,000 human beings working continuously for 24 hr.

News Notes

LINK-BELT CO., 910 So. Michigan Ave., Chicago, Ill., announces the appointment of J. J. Hartley to the position of chief engineer of the company's Pershing Road Plant at Chicago, Ill. He was formerly in charge of Foundry Equipment Sales in the Western Division of the Link-Belt organization. For the past 19 yr. he has held various positions with the company and he brings to the engineering department a vast amount of practical experience coupled with his engineering ability. W. L. Hartley, his brother, formerly assistant in the Foundry Equipment Sales Department, has been appointed manager of this department.

ERWIN E. DREESE has been appointed Professor of Electrical Engineering at Ohio State University, as part of a program of adding more men of national reputation to the faculty of the university, the appointment becoming effective Jan. 1.

He is a graduate of the University of Michigan, where he received his Electrical Engineering degree in 1920. His studies at Michigan were interrupted in 1917 when he enlisted in the Signal Corp of the U. S. Army, as a private, for the duration of the war. When hostilities ceased, he was a company commander in a signal officers' training camp. Upon graduation he was made instructor of electrical engineering at Michigan, and for the next 4 yr. was teaching and working for a Master of Science degree which was conferred upon him in 1924.

Joining The Lincoln Electric Co., where Prof. Dreese has been employed for the last 5 yr., he was made Chief Engineer after one year.

Professor Dreese is a member of Tau Beta Pi, honorary engineering fraternity, of Sigma Xi, honorary scientific society and of the American Institute of Electrical Engineers.

SIMPLEX VALVE AND METER CO., Philadelphia, Penna., announces the appointment of Neville & Cleary, Inc., Candler Building, Atlanta, Georgia, as its representative for the sales of its products in the territory south of Virginia, West Virginia and Kentucky line and east of the Mississippi River. A. C. Hays will be in charge of branch office at New Orleans, La.

H. S. FORD, eastern sales manager of R. H. Beaumont Co., Philadelphia, Penna., has been transferred to the New York Office at 50 Church St. In conjunction with H. W. Ruth of that office, he will handle all sales matters in the New York district. H. B. Mosley, New York manager of the Beaumont Mfg. Co., a division of the R. H. Beaumont Co., is now connected with the Philadelphia office of the latter company.

BUFFALO FORGE CO. and Buffalo Steam Pump Co., Buffalo, N. Y., announce that their Chicago office and stock room are now located in larger quarters at 15 North Jefferson St., Chicago, Ill. Telephone numbers remain unchanged.

NEVILLE & CLEARY, INC., Candler Building, Atlanta, Ga., and New Orleans, La., now represents The Edward Valve & Manufacturing Co. of East Chicago, Ind., in the Southeastern states. This is the territory formerly covered by W. J. Neville, deceased.

BROWN INSTRUMENT CO., Philadelphia, has appointed E. B. Nichols as its chief engineer. Mr. Nichols, who is an M.E. graduate of North Carolina State College, was at one time chief engineer of the Pfaudler Co., Rochester, N. Y., subsequently holding the position of chief engineer of the Victor Talking Machine Company, Camden, N. J. Later he became associated with the Bell Telephone Laboratories, which connection he severed to join The Brown Instrument Co. organization.

WARREN STEAM PUMP CO., INC., announces the appointment of The Tennant Co. of Houston, Texas, to handle its products in the Southern half of Texas.

CHARLES M. NUCKOLLS has resigned his position with The International Harvester Co., Tractor Works, Chicago, Ill., to accept a position with H. D. Conkey & Co., Mendota, Ill. Mr. Nuckolls will take charge of design and development work in the crane department of this company. Prior to his connection with the International Harvester Co., Mr. Nuckolls was associated with the Whiting Corp., Harvey, Ill., and the Shaw Crane Works, Muskegon, Mich.

STEPHENS-ADAMSON MFG. CO., has recently established a new branch engineering and sales office at 521 Skinner Bldg., Seattle, Wash., under the supervision of Charles J. Horn, formerly assistant chief engineer for the firm.

JAMES WATSON, Founder and Treasurer of Watson & McDaniel Co., Philadelphia, Pa., pioneer in the steam specialty industry, died Sunday, December 15, 1929, at his home, 1623 Mt. Vernon St., Philadelphia, Pa., at the age of 92.

Mr. Watson was born in Philadelphia, October 26, 1837. Graduating from the Friends Farm School, he entered the firm of Watson and Evans, safe manufacturers; the senior member of this company was Mr. Watson's father. They later purchased the interest of Mr. Evans and the firm name was then changed to J. Watson & Son. At the death of his father, Mr. Watson continued the manufacture of safes until 1878, when he formed a partnership with John S. McDaniel, which partnership was known as Watson & McDaniel Co. In 1897, Mr. Watson purchased the interest of John S. McDaniel and incorporated the company and, at this time, his son, James P. Watson, was made president of the company, holding his position until his death in 1925.

After his son's death, Mr. Watson disposed of all of his holdings in the Watson & McDaniel Co. He maintained his interest, however, and honored the company by acting as treasurer. Although almost to the century mark in years, he was progressive and alive to the various changes in business and his interest in affairs of the day was only ended by his death.

STANDARD GAS & ELECTRIC CO. are announced to take over assets of Standard Power & Light Corp'n., including 94 per cent of the common stock of The Philadelphia Co. which, in turn, controls Duquesne Light Co. operating power, light, gas and transportation in Pittsburgh and vicinity. Standard Power & Light Corp'n. will, in the transfer, acquire a majority of the common stock of Standard Gas & Electric Co.

This transaction will bring into affiliation H. M. Byllesby & Co., United States Electric Power Corp. and the companies above mentioned, representatives of Byllesby and United States interests making up the boards of directors of the Standard Gas and Standard Power organizations. Standard Gas & Electric has installed capacity of 1,375,081 kw. with 136,000 kw. under construction, serves 1,572,193 customers and has combined assets of $1,100,000,000.

SULLIVAN MACHINERY CO., 400 North Michigan Ave., Chicago, Ill., announces the establishment of a branch office at Johannesburg, South Africa, as Sullivan Machinery Co., Africa (Proprietary) Ltd., Geneva House, Johannesburg Transvaal. Charles C. Smith, formerly of the Sullivan staff but more recently manager for Barlow's Johannesburg (Proprietary) Ltd., Sullivan agents in South Africa, will be manager of the new office. A branch office, warehouse, and service station for Sullivan equipment has been established at N'Dola, in Northern Rhodesia.

RESIGNATION of Ray M. Hudson, assistant director of the National Bureau of Standards, in charge of commercial standardization, to become effective December 31, 1929, was recently announced by that Bureau. Mr. Hudson, on January 2, 1930, will assume new duties as Secretary of the Massachusetts Division of the New England Council, with headquarters in Boston, Mass.

Ever since his graduation from Syracuse University in 1908, Mr. Hudson has devoted his best efforts to the study of simplification, standardization and scientific management methods and today is recognized nationally as an authority on the elimination of industrial waste. He has been a frequent contributor to technical, trade and business magazines and has prepared the section on simplification and standardization for two successive editions of the Encyclopedia Brittanica.

Before being called by Mr. Hoover, then Secretary of Commerce, as technical assistant in the Division of Simplified Practice, he was associated for several years with Col. George D. Babcock, a member of the Hoover Committee on Waste in Industry, in the installation of scientific management methods in the plants of the H. H. Franklin Manufacturing Co., Syracuse, N. Y. and of the Holt Manufacturing Co. at Peoria, Ill. During the war he served with the Emergency Fleet Corporation, as a production engineer in the procurement of machinery. In 1923, Mr. Hudson was made assistant chief of the Division of Simplified Practice, and in 1925, its chief. With the creation, in September, 1927, of the Commercial Standardization Group within the Bureau of Standards, he became an assistant director of the Bureau, in charge of this work. During the time Mr. Hudson has been associated with the Department of Commerce, 117 simplified practice recommendations, 18 commercial standards, and more than 60 marine standards have been developed by their various industries.

Mr. Hudson is a member of the Taylor Society, the Society of Automotive Engineers, Committee on Uniform Traffic Regulations of the National Street and Highway Conference, Committee on Expenses of Doing Business of the National Distribution Conference, Committee on Research of the American Engineering Council, Committee on Waste Elimination of the Society of Industrial Engineers, the National Research Council's committee on Industrial Lighting, the National Committee on Wood Utilization and others. For 2 yr., 1926 and 1927, he served as Secretary of the National Management Week Committee, directing management week meetings in nearly 100 cities.

DIESEL ENGINE Manufacturers' Association, 30 Church St., New York, announces the election of the following officers for 1930: President, A. E. Ballin of McIntosh & Seymour Corp., Auburn, N. Y.; vice-president, Geo. Codrington of Winton Engine Co., Cleveland, Ohio; chairman executive committee, E. T. Fishwick of Worthington Pump & Machinery Corp., 2 Park Ave., New York; chairman technical committee, H. W. Dow of Nordberg Mfg. Co., Milwaukee, Wisc.; secretary and treasurer, H. A. Pratt of Ingersoll-Rand Co., 11 Broadway. Members of this association have agreed upon a number of engineering standards which should be of assistance to buyers. These agreements will be formally presented in the near future in a book entitled The Standards of the Diesel Engine Manufacturers' Association.

WILLIAM MCPHERSON, dean of the Graduate School of Ohio State University, became president of the American Chemical Society on January 1 as a result of the Society's annual election. Dean McPherson will serve during 1930, succeeding Dr. Irving Langmuir, associate director of research of the General Electric Co. Moses Gomberg, professor of chemistry in the University of Michigan, was chosen president for 1931. In accordance with a recent change in its constitution, the Society now elects each year a president and a president-elect, who serve in successive years. Prof. James F. Norris of Massachusetts Institute of Technology, and Charles L. Reese of E. I. du Pont de Nemours & Company, Wilmington, Del., were elected directors for 1930-1932.

The American Chemical Society, Secretary Charles L. Parsons of Washington reported, now has 17,457 members an increase of 1200 during the year. The publications of the Society were declared to be in a flourishing condition.

Books and Catalogs

AN INVESTIGATION of the Friability of Different Coals; by Cloyde M. Smith; published by the University of Illinois, Urbana, Ill., as Bulletin No. 196 of the Engineering Experiment Station; 47 pages; price, $0.30.

Report of an investigation of over 500 coal samples to show the degradation in weight and size when dropped from a definite height. Weight degradation ranged from 19 per cent for Illinois cannel coal to 60 per cent for Pocahontas; size degradations carried from 8 to 39 per cent for the same coals, giving the ratio of size to weight degradation from 0.4 to 0.6 with Illinois coals averaging roughly 0.5.

CHEMICAL DICTIONARY; by Ingo W. D. Hackh; published by P. Blakiston's Son & Co., 1012 Walnut St., Philadelphia, Pa.; 790 pages; price, $10.00.

Although arranged alphabetically with a key to the pronunciation, this dictionary is more in the nature of an encyclopedia, a modern clear and concise description of the theories, laws and rules, chemical composition, reactions and processes; equipment and biographical data of all industries and all branches of science which chemistry touches. Furthermore, the common terms used in different industries are given side by side with the chemical or scientific term. The book is well illustrated throughout with modern diagrams and photographs.

THE ROAD TO ECONOMY IN BUILDING is discussed by Morton C. Tuttle Co., Boston, Mass., in a recent bulletin.

REX POWER PLANT EQUIPMENT for industrial power plants and central stations is the title of the folder just issued by the Chain Belt Co., Milwaukee, Wisc.

BETTER BOILER BRICKWORK AND MONOLITHIC CONSTRUCTION is the title of a 12-page illustrated bulletin recently issued by Refractory & Engineering Corp., 50 Church St., New York City. This describes a complete line of specialized refractory cements for the power plant, each one prepared to meet certain specific conditions in every-day refractory service. For monolithic work, Moldit is designed to withstand temperatures up to 3000 deg. F. while Moldit-A is designed for temperatures between 200 and 2400 deg. Use of R. & E. No. 3000 is described for laying-up and hot and cold patching with brickwork, for temperatures up to 3000 deg. The catalog includes an interesting group of boiler cross-sections showing how and where the various cements should be used.

CATALOGUE 75, just issued by the Robins Conveying Belt Co., 15 Park Row, New York City, is a 300-page, cloth bound book covering the entire subject of material handling equipment. Various types of belt conveyors and their parts are illustrated and described, as well as portable conveyors, bucket elevators, crushers, grizzlies, weigh larries and similar equipment. New types of vibrating screens are discussed in detail. Besides information about the equipment itself, the bulletin contains a large quantity of engineering information regarding design and selection of equipment. Charts of speeds, horsepowers and capacities are given wherever necessary and a general engineering discussion of the various classes of equipment accompanies the detailed descriptions.

ASCO VALVES, which are solenoid magnet valves, are described in detail in a new bulletin issued by Automatic Switch Co., 154 Grand St., New York City. Tables of sizes and prices are included and the new form S heavy duty valve in sizes up to 12 in. for steam pressures up to 400 lb., 750 deg., is also described. This valve is of the packless type.

MARLEY STEAM SUPERHEATERS for horizontal return tubular boilers are described in detail in Catalog 23 by the Marley Co., 1737 Walnut St., Kansas City, Mo. This describes a new model of the Type B unit with crossed tubes and shows the way these superheaters are installed under various conditions. In Bulletin 24, the company describes its new spray deck towers. These consist of a conventional form of deck type cooling tower with a spray cooling system in the top. Details of the parts are illustrated and described.

AUTOMATIC SWITCHING EQUIPMENT for waterwheel-driven generators is described, with wiring diagrams and other details, in Bulletin GEA-153B by General Electric Co., Schenectady, N. Y.

MOODY HIGH SPEED PUMPS for low and medium heads is the subject of Bulletin No. 9 sent out by I. P. Morris & De La Vergne, Inc., Richmond and Norris Sts., Philadelphia, Pa. This pump is designed to operate at more than double the speed of a centrifugal pump for the same conditions and thus to take advantage of the reduced size of the modern motor and to reduce the size of the pump itself. The pump is for the most part limited to heads under about 40 ft. with unit capacities ranging from 300 g.p.m. up to the largest that may be demanded. Impeller is of the single suction, unshrouded type, overhung on the end of the shaft and is furnished in both vertical and horizontal designs.

ARC WELDING of Pipe Lines is the title of a pamphlet issued by Lincoln Electric Co., Cleveland, Ohio, illustrating and describing in detail methods that have been used on a considerable number of important lines and also the equipment which the company manufactures for this purpose.

PIPE WELDING WITH STOCK Fittings in the New Power Plant at the Bureau of Standards, Washington, D. C., is described and illustrated in a recent bulletin by Tube-Turns, Inc., Louisville, Ky. The bulletin shows several pipe layouts as originally designed and then as actually installed with tube turns welded into the lines instead of other types of fittings. Photographs of various parts of the piping are presented to show how the fittings appear in place.

HOLBROOK TRAPS are described and illustrated in an attractive catalog issued by A. W. Holbrook & Sons, Inc., Palmer, Mass. Applications for paper machinery, for radiators and details of construction and operating mechanism are clearly shown.

FABRICATION of Welded Piping Designs is a booklet intended for the use of the executive, welder foreman or welder, to enable him to apply successfully fundamental designs of welded piping. The booklet contains procedure controls for line joints and fittings, templet layout for pipe fittings and tables for estimating costs. Copies can be obtained from the Technical Publicity Dept. of Linde Air Products Co., 30 East 42nd St., New York, N. Y.

GENERAL ELECTRIC Co., Schenectady, New York, has recently issued three bulletins on outdoor switching equipment. One of these, GEA-1004A, deals with hook operated disconnecting switches. Another one, GEA-1122, deals with insulators and a third, GEA-1003A, covers group operated outdoor insulating switches. These three bulletins present concise information on the various types of equipment, details of which are shown by means of photographs and drawings. Sizes and dimensions are given in tabulation but these are to be used for estimating purposes only.

VULCAN SOOT CLEANERS for all types of water tube and return tubular boilers, superheaters and economizers are illustrated and described in a 38-page, illustrated bulletin by the Vulcan Soot Cleaner Co., Du Bois, Pa. This publication discusses requirements of an efficient soot cleaner and describes the various models of Vulcan cleaners with details of their parts and illustrations of their applications to all types of boilers.

MOTOCO INDUSTRIAL thermometers, their uses and construction are described in Catalog No. 4 issued by Moto Meter Co., Inc., Wilbur Ave., Long Island City, N. Y.

Power Plant Construction News

Ariz., Prescott—The Bagdad Mining Co., Prescott, plans installation of power equipment at proposed new copper ore reduction plant, entire project to cost more than $4,000,000.

Ark., Harrison—The Arkansas Power & Light Co., Pine Bluff, is said to have preliminary plans under way for a hydro-electric generating plant at Harrison to cost close to $1,000,000, with transmission system.

Calif., Oakland—The H. B. Body Co., Nineteenth and Livingston Streets, plans construction of one-story boiler plant at new factory unit on West Sixty-sixth Avenue, entire project to cost $95,000.

Colo., Boone—S. A. Geerrard & Co., Colorado Building, Pueblo, R. A. Hollander, head, plans installation of electric pumping machinery and auxiliary equipment in connection with an irrigation development in the vicinity of Boone, entire project to cost more than $100,000. W. H. Sawhill, 543 West Orman Avenue, Pueblo, is engineer.

Colo., Trinidad—The Bear Canyon Coal Co., Trinidad, plans installation of electric power equipment in connection with rebuilding of tipple at its Bear Canyon mine near city, entire project reported to cost about $65,000.

D. C., Washington—The Potomac Electric Power Co., Fourteenth and C Streets, is having plans drawn for a two-story addition to its Bennings steam-operated electric power plant, reported to cost $1,800,000. Stone & Webster, Inc., 49 Federal Street, Boston, Mass., is engineer.

Fla., Pensacola—The Armstrong-Newport Co., West Main Street, plans installation of electric power equipment in proposed local plant for the manufacture of insulating board, entire project to cost more than $750,000; a boiler plant is proposed.

Ga., Macon—The Dixie Ice Cream Co., Cotton Avenue, plans installation of electric power and refrigerating equipment in proposed new plant unit on Arch Street, entire project to cost about $80,000.

Ill., Arlington Heights—The Hume Pipe Corporation, Arlington Heights, plans installation of electric power equipment in proposed new concrete pipe manufacturing plant on local site, entire project to cost $100,000.

Ill., Dwight—The Keeley Hospital Association, Dwight, plans construction of a one-story boiler plant in connection with a new institutional building, entire project to cost close to $70,000. F. B. Gray, 67 South La Salle Street, Aurora, Ill., is architect.

Iowa, Ridgeway—The Common Council is said to be considering installation of pumping machinery and auxiliary equipment in connection with proposed municipal waterworks, for which a fund has been voted. F. W. Mack, Storm Lake, Iowa, is engineer.

Kan., Hays—The Board of Regents, State House, Topeka, Kan., has preliminary plans under way for a one-story power plant at institutional building at Hays, reported to cost about $35,000, with equipment. N. W. Radotinsky, State House, is architect.

Ky., Sturgis—The City Council is said to be planning the installation of pumping machinery and auxiliary equipment in connection with a water works system for which estimates of cost will soon be made. Black & Veatch, Mutual Building, Kansas City, Mo., are engineers.

La., New Orleans—The Sugar By-Products Corp., Pere Marquette Building, plans installation of electric power equipment in proposed commercial alcohol and byproducts plant, entire project to cost close to $100,000.

Md., Chestertown—The Chestertown Electric Light & Power Co. plans extensions in transmission lines in Queen Anne's County, with power substation facilities.

Mich., Detroit—The Board of Works, is having plans completed for a pumping plant at Nine Mile Road and Jefferson Avenue, reported to cost more than $65,000, with equipment. Hubble, Hartgering & Roth, Buhle Building, Detroit, are engineers.

Miss., McComb—The McComb Creamery & Ice Cream Co. plans installation of electric power equipment in proposed new plant unit to cost about $100,000. A. F. Hansen, Shrine Building, Memphis, Tenn., is architect.

Mo., Kansas City—The Kansas City Power & Light Co. is completing plans for a power substation at Forty-seventh Street and Broadway, reported to cost more than $50,000, with equipment. H. G. Freshman, Fourteenth Street and Grand Avenue, is architect.

Mo., St. Louis—The Board of Education, Board of Education Building, plans construction of a one-story power house, 72 by 150 ft., on School Street, reported to cost more than $60,000, with equipment.

N. Y., Hornell—The Erie Railroad Co., 50 Church Street, New York, plans installation of electric power equipment in proposed addition to railroad shops at Hornell, entire project to cost $100,000.

N. D., Fargo—The Union Storage & Transfer Co. has plans for a four-story cold storage and refrigerating plant to cost more than $200,000. W. F. Kurke, 54 Broadway, Fargo, is architect.

Ohio, Boliver—The Timken Roller Bearing Co., Canton, Ohio, is said to have plans under way for a one-story power plant for works service, at Boliver, Ohio, reported to cost more than $75,000.

Ohio, Oak Harbor—The Thierwachter Milling Co. is considering the installation of electric power equipment in connection with proposed rebuilding of feed milling plant, recently destroyed by fire, with loss reported in excess of $100,000.

Okla., Marlow—The City Council is said to be planning the installation of pumping machinery and auxiliary equipment in connection with proposed municipal waterworks, entire project to cost about $60,000. D. V. Long & Co., Colcord Building, Oklahoma City, Okla., are engineers.

Ont., Hamilton—The Coffield Washer Co., 80 Niagara Street, North, plans installation of electric power equipment in proposed three-story factory addition to cost $100,000, for which a building permit has been issued.

Pa., Concord—The Board of Delaware County Commissioners, Court House, Media, has preliminary plans under way for a steam power plant at Concord for central heating service, reported to cost more than $60,000.

Pa., McKeesport—The Columbia Radiator Co. plans installation of electric power equipment in proposed new plant addition to cost more than $200,000.

Pa., Spring Mill—The Reilly-Whiteman Co., Conshohocken, Pa., plans installation of electric power equipment in proposed refined oil and tallow manufacturing plant at Spring Mill, entire project to cost about $80,000.

Pa., Uniontown—The Richmond Radiator Co., Uniontown, plans installation of electric power equipment with an expansion program at local plant, including removal of present plant at Norristown, Pa., to this location, entire project to cost more than $75,000.

Tenn., Jackson—The American Creosote Works, Inc., New Orleans, plans construction of a boiler plant at proposed creosoting plant at Jackson, entire project to cost more than $200,000.

Tex., Deport—The Common Council is said to be planning the installation of pumping equipment and auxiliary apparatus in connection with proposed municipal water system, for which a bond issue of $45,000 has been approved.

Tex., Beaumont—The Beaumont Coco-Cola Bottling Co., 795 Main Street, plans installation of electric power equipment in proposed new plant unit to cost $150,000, on site recently selected at Asheley and Mariposa Streets.

Wis., Milwaukee—The Pittsburgh Plate Glass Co., Frick Building, Pittsburgh, Pa., plans installation of power equipment in first unit of proposed paint manufacturing plant addition at Milwaukee, for which revised plans are nearing completion, entire project to cost close to $1,000,000.

Wis., Sheboygan—The Wisconsin Power & Light Co., Madison, Wis., plans construction of power plant at Sheboygan, reported to cost close to $40,000.

Wyo., Thermopolis—The Common Council is said to be planning the installation of pumping machinery and auxiliary equipment in connection with extensions and improvements in municipal waterworks, for which a bond issue of $35,000 has been approved.